UNIVERSITY of VIRGINIA
SCHOOL OF MEDICINE

P.O. Box 800793
Charlottesville, VA 22908-0793
434-982-4050 | Fax 434-982-0874

Office of the Dean

November 26, 2019

The Honorable Ralph S. Northam
Governor

The Honorable Thomas K. Norment, Jr.
Co-Chair, Senate Finance Committee

The Honorable Emmett W. Hanger, Jr.
Co-Chair, Senate Finance Committee

The Honorable S. Chris Jones
Chair, House Appropriations Committee

Dear Gentlemen:

On behalf of Eastern Virginia Medical School, Old Dominion University, Sentara Health System, the Hampton Roads Community Foundation and Virginia Commonwealth University Health System, I am pleased to submit to you for consideration the Hampton Roads Biomedical Research Consortium Proposed Strategic Plan.

As per the conditions set forth in HB 1700 (Chapter 854) the institutions referenced above have met numerous times this year, and working via a consulting firm (Teconomy), have developed a robust plan to establish a research consortium that will benefit the Hampton Roads region. In the course of this planning process the work group has (i) identified areas of research relevant to the Hampton Roads region, taking into account existing biomedical public and private assets, (ii) conducted a health risk assessment of the region's population; and (iii) identified cost-sharing strategies between and among the partnering institutions to include matching requirements.

The members of the work group have worked diligently to craft a proposal that builds on each institution's respective strengths that when pooled has the potential to produce impactful synergy. The members believe that the findings in the report accurately portray the opportunities and challenges for the Hampton Road Biohealth Research Consortium.

It has been my pleasure and honor to serve in a convening capacity for this work group.

Sincerely,

David S. Wilkes, MD
Dean, UVA School of Medicine
James Carroll Flippin Professor of Medical Science

CC:
Robert Vaughn, Staff Director
House Appropriations Committee

April Kees, Staff Director
Senate Finance Committee

CC: Members of the HRBRC Work Group

Jordan Asher, MD
William J. Wasilenko, Ph.D.
Morris Foster, Ph.D.
John O. Semmes, Ph.D.
Rick Homan, MD
Deborah DiCroce, Ed.D
Brant M. Cox, MBA
Michael Gentry, MBA
Peter Buckley, MD
Dubby Wynne, JD
Mitch Horowitz, MPP
Jonathan Dworin, MPP
Annie Morris, MPA
Anna James, MBA
Karah L. Gunther, JD
Sally N. Barber, ESQ
Elizabeth B. Daley, MBA

A PROPOSED STRATEGIC PLAN:

Establishment of a Hampton Roads Biomedical Research Consortium

Proposed by:

EVMS
Eastern Virginia Medical School

OLD DOMINION
UNIVERSITY

SENTARA™
HEALTHCARE

Assistance from TEConomy Partners, LLC. in coordination with the University of Virginia

TABLE OF CONTENTS

THE BRIEF

Eastern Virginia Medical School (EVMS), Old Dominion University (ODU) and Sentara Health System have worked together to develop a plan to establish the Hampton Roads Biomedical Research Consortium (HRBRC), authorized in the Budget Bill for FY 2020.

WHAT ARE THE PROBLEMS TO SOLVE:

- Support the educational and health institutions in the region
- Address pressing population health needs and disparities in the region
- Offer a pathway from research to commercialization, new startup formation and broader industry partnerships

WHAT DOES SUCCESS LOOK LIKE:

- Use data analytics to develop innovations that improve population health and reduce health disparities in the region
- Advance applied research and develop clinical applications of bioinformatics, healthcare delivery science, health system engineering and biomedical engineering (devices/sensor/electronic health record applications) that enhance the respective national, academic and clinical reputations of EVMS, ODU and Sentara
- Catalyze a new economic development driver for the region in biohealth

HERE'S HOW WE GET THAT DONE:

- Start with a focus that addresses the needs of the region's Medicaid population, since Medicaid is a publicly-funded system that captures many of the health disparities and inequities in the region
- Turn healthcare data into knowledge by establishing a health analytics infrastructure that drives innovation in biohealth products and services
- Invest in the region's applied research assets focused on innovation, such as modeling and simulation, digital health and diagnostics.

(The Hampton Roads Biohealth Research Consortium will leverage the region's applied research and health analytics assets to address pressing health needs and disparities and advance biohealth innovation.)

INTRODUCTION

In the 2019 legislative session, Virginia's General Assembly called for the establishment of the Hampton Roads Biomedical Research Consortium (HRBRC), with initial funding of $4 million in general funds and $10 million in capital funds for FY20. This is a substantial step for advancing and catalyzing an emerging research and innovation-led economic driver in the region, while also addressing the region's significant unmet health needs and disparities that serves as a barrier to further economic growth and prosperity of the Hampton Roads region.

The legislative language provided guidance for convening a Work Group of EVMS, ODU, the Community Foundation and a leading not-for-profit hospital, Sentara Health System, facilitated by the University of Virginia, to complete a plan for the HRBRC to be submitted to the General Assembly for approval. The guidance in the legislative language required that the plan:

- Identify areas of research relevant to the region taking into account the region's biomedical public and private assets
- Conduct a health risk assessment of the region's population
- Identify cost sharing strategies between and among the partnering institutions and entities to include matching requirements

To assist in developing the HRBRC Plan, the Work Group retained the services of TEConomy Partners, LLC., a leading national technology-based economic development organization with significant expertise and experience in advancing biosciences roadmap for more than 30 states and regions across the U.S. Over the 2017-2019 period, TEConomy assisted the Virginia Research Investment Committee in its comprehensive assessment of the Commonwealth's research assets across industry, universities and federal labs located in the state, entitled Assessment of Virginia's Research Assets: Strategic Directions to Advance Innovation-led Growth and High-Quality Job Creation across the Commonwealth (the "Report") and implementation planning. In addition, TEConomy recently worked with the Virginia Growth and Opportunity Board to conduct entrepreneurial assessments for each of the nine GO Virginia regions, including Region 5 covering Hampton Roads.

The approach for this HRBRC Plan is to offer a forward-looking development model that builds upon the region's existing and emerging assets and interests of Consortium members in advancing biomedical-related research. Rather than simply following traditional models of biomedical development, a more cutting-edge approach is proposed that targets a new 21st century "biohealth" development pathway linking biomedical innovation with technology advancements to improve health care delivery in response to the high costs of healthcare in the U.S. and the need for improved health outcomes and reduction of persistent health disparities.

STRATEGIC DIRECTIONS

This Plan breaks new ground in identifying how the three founding Consortium members – EVMS, ODU and Sentara – can work together in a sustained, collaborative and organized approach that advances applied research informed by health analytics to address population health needs and health disparities and to commercialize new healthtech innovations and applications that can be commercialized through applied research.

The strategic approach to advancing biohealth development in the region, in turn, has its own dynamics in how that development is achieved. The value creation model for biohealth development places specific requirements on HRBRC to offer program activities and make key investments in order to have a high-functioning system in place. The program activities and investments to be undertaken by HRBRC then help determine the organizational structure and governance required by HRBRC to carry out the Plan effectively.

The HRBRC will build up its capacities and perfect its approach by starting with a focus on addressing the needs of targeted subgroups of the region's Medicaid population. Medicaid provides an important starting point for HRBRC because it is a system that captures many of the health disparities and inequities found in the region. Often efforts to address population health needs and health disparities among Medicaid patient populations lack a full understanding of how dynamics of socio-economic conditions contribute to poor health.

HRBRC can bring a more analytical and in-depth approach to benefit the Consortium members and community stakeholders by learning from exploring together multiple kinds of data – clinical as well as broader social determinants of health -- to discover new questions to ask, test novel hypotheses and integrate biomedical and healthtech innovations into more robust solutions involving community resources.

Strategic Goals, Mission and Objectives to Guide HRBRC

With the guidance of the Work Group, comprised of key participating organizations identified by the legislation calling for the establishment of the Hampton Roads Biomedical Research Consortium (HRBRC), a set of overall goals for the Consortium and a strategic objective based on the region's assets in biohealth has been advanced.

STRATEGIC GOALS:

- Strengthening the region's biohealth innovation for economic development
- Advancing alignment and collaboration among the Partnering Institutions
- Addressing health disparities through improved healthcare delivery to underserved populations

MISSION:

The Hampton Roads Biohealth Research Consortium will leverage the region's applied research and health analytics assets to address pressing health needs and disparities and advance biohealth innovation.

Among the key objectives to achieving this mission are:

- Identify specific innovation needs for population groups, such as the Medicaid population, which faces significant healthcare disparities that can be addressed through applied research.
- Advance a regional learning system of turning healthcare data into knowledge, translating that knowledge into improvements in health diagnosis, treatment and delivery and creating new data by means of those innovations to further generate new insights and knowledge.
- Create innovations that advance new market demands for value-based and patient-centered healthcare

The development of this strategic mission was informed by the situational assessment and likely path for sustained economic development and improved healthcare delivery and outcomes to address health disparities found in the region.

For the three key participating organizations involved in HRBRC – EVMS, ODU and Sentara – there is a very high value proposition from the proposed strategic mission. Among the common benefits are:

- Access to enhanced analytics on clinical databases linked to broader socio-economic data that can directly lead to improvements in healthcare delivery and outcomes, and accelerate the digital engagement with patients
- Catalyzing public-private collaborations among the participating organizations and other stakeholders to pursue applied research that can lead to increased federal research funding and generate innovative solutions for commercialization leading to new venture creation and industry partnerships
- Advance talent attraction and generation both at the student and faculty/researcher level

Initial Partner Identification of Benefits from the Proposed HRBRC Strategic Mission

For EVMS:

- Augment already established research in analytics and population health/consumer health that addresses community health needs
- Focused and applied research with potential public-private collaborations with technology development and commercialization opportunities
- New collaborative grants among the partners
- Opportunity to attract research talent in the topic areas and to augment and train a digital health work-force

For Sentara:

- Enable access to enhanced analytics
- Improve digital engagement strategies
- Enhanced care
- Provide talent
- Further innovation in health care through collaborations in technology development and commercialization opportunities

For ODU:

- Extend and grow existing modeling & simulation, data analytics, and systems engineering strengths through collaborations with Sentara and EVMS in interrogating rich, complex clinical databases, with the opportunity to link those with non-clinical databases (such as census, climate, traffic, environmental exposures, social media, etc.);
- Institutionally-aligned collaborations with clinicians at both Sentara and EVMS to generate hypotheses based on that data-mining, which then can be tested to identify potential digital health solutions (algorithms, software, devices, etc.);
- Collaborations with Sentara and EVMS in developing those solutions as digital health applications to clinical and health system challenges;
- Access to a health system testbed to test and validate these digital health applications within the broader context of Internet of Things and Systems of Systems frameworks and solutions;
- Institutional partners in bringing some of those applications to commercial markets.
- Impact patient and community health outcomes through these activities, first locally and then globally.
- In the course of these (and other) opportunities, we'll be able collaboratively to train students, pursue grants and research, and build the university's biomedical teaching and research capabilities.

SITUATIONAL ASSESSMENT

Across the nation, the advancement of regional biomedical clusters is one of the most sought after growth targets for economic development because it represents a large, fast-growing and diverse market for innovation that can drive economic vitality, while also improving healthcare and the quality of life in a region. The Pharmaceutical Research and Manufacturers of America (PhRMA) report that 41 states have some form of statewide strategy or focus on attracting and growing the biopharmaceutical industry or broader biosciences and often multiple regions within a state will have their own approaches to building on their assets and industry activities to pursue biomedical development.[1]

Successful regional and state biomedical strategies focus on their specific assets in biomedical development and then tailor their strategic development approaches and specific actions to realize innovation-based growth opportunities from those assets. Thus, the key building block for the HRBRC plan is the identification of research relevant to the Hampton Roads region that brings together a knowledge of public and private biomedical assets in the region and an understanding of the region's population-based health needs into a strategic opportunity assessment of potential focus areas.

The key findings from the detailed assessment of the Hampton Roads biomedical assets and population health needs suggest that the Hampton Roads region has a distinct pathway for successful biomedical development that differs from many of our nation's leading biomedical regions who build upon significant strengths in basic research (see appendices for details of the situational assessment).

Typical of most regional biomedical development strategies is the recognition that biomedical development stands apart from other technology sectors in the close relationship between basic and clinical research activities, found largely at universities and academic medical centers, and the significant efforts required to advance new product development, from drug development and pre-clinical research to clinical trials and regulatory approval. This has led most regional biomedical strategies to focus on leveraging basic biomedical research strengths found among regional academic institutions to drive new discoveries that can be commercialized through translational "bench to bedside" research activities and lead to forming new ventures or licensing with local industry partners as depicted in Figure 1.

The Hampton Roads region, in contrast, has more applied research and healthcare delivery assets that suggest a different development pathway should be pursued that more explicitly links biomedical innovations in areas like diagnostics with advancements in digital technologies to improve health care delivery in response to the high costs of healthcare in the U.S. and the need for improved health outcomes and reduction of persistent health disparities. As Bain & Company explains:

1 *PhRMA, Driving Innovation and Economic Growth for the 21st Century: State Efforts to Attract and Grow the Biopharmaceutical Industry, December 2016, page 23.*

Figure 1. Traditional Biomedical Research Development Approach

> "...the focus of innovation will shift from the product arena to healthcare delivery...the shift in emphasis from managing inputs, like the rate of adoption of new products and the number of physician visits, towards delivering outputs, like patient satisfaction, clinical outcomes and overall system savings, is already well underway." [2]

The development focus for Hampton Roads to pursue might better be termed "biohealth" in contrast to "biomedical." This biohealth development pathway centers on the significant ongoing movement away from patient fee-for-service to value-based models of financing healthcare and the opportunities to improve healthcare delivery through the increasing generation of digital records in healthcare that can be analyzed using advanced Big Data analytics to generate new knowledge and inform decisions in real-time.

In this biohealth development pathway value-based healthcare and health analytics are integrally linked together, and the focus is on improving the quality of care and health of the population while reducing the overall costs of healthcare delivery. Analytics technology and techniques, become a pivotal connective resource providing the insights into costs, risks and patient outcomes that value-based healthcare and innovations in healthcare diagnosis, treatment and delivery depends.[3]

This biohealth development pathway is often referred to as the market for population health management. It is already a sizable and growing market. Grandview Research, a market research firm that specializes in healthcare, projects the population health management market to reach $50.3 billion by 2026 in the U.S., a 20.1 percent compounded annual growth rate from 2018 to 2026.[4] Common elements of solutions found in this market include the ability to stratify population groups at risk, identify high-cost diseases and enlist patients to participate in disease management programs that utilize innovative solutions in digital health, diagnostics and improved treatments, typically in combination. Hospitals and health systems are often the leaders in advancing health management innovations, which are already demonstrating opportunities for new spin-off companies from commercialization activities (see text box).

2 *George Eliades et al, Healthcare 2020: To Win in a Shifting Profit Pool, Companies Need to Improve How Healthcare is Delivered, Bain & Company, 2012, page 1.*
3 *Duke Fuqua School of Management, Value-based Healthcare and the Role of Health Analytics, April 8, 2019, page 3.*
4 *See https://www.grandviewresearch.com/press-release/us-population-health-management-market-analysis*

Hospital and healthcare system's health management efforts are generating startups to commercialize new technology solutions

Providence St. Joseph Health System (WA) – Through its incubator it has launched several population health management companies including:

- Ayin Health Solutions to equip payers, providers, employers and government entities with the skills to lower costs, improve care and keep up with healthcare's transition to population health;
- Circle Women's Health Platform created by clinicians at PSJH to provide clinicians and patients various tools and trackers (acquired by Wildflower Health);
- Xealth, which completed a $14 million round of Series A financing last year, has advanced a digital health application that allows clinicians to prescribe and monitor digital content within the EHR system and then share information directly with patients.

Boston Children's Hospital through its Innovation & Digital Health Accelerator has launched several startups

- Epidemico is a commercial spinoff of Boston Children's Hospital, Harvard Medical School and the Massachusetts Institute of Technology. The start-up is known for creating HealthMap, an online mapping tool that tracks the spread of diseases using a computer algorithm. Purchased by Booz Allen in 2014 for an undisclosed price.
- "Mightier, a Boston Children's Hospital spinout that makes biofeedback video games to help children with emotional regulation. The spinout has raised upwards of $10 million since its launch.
- Circulation: Spun out of Boston Children's Hospital with more than $10M in VC funding, Circulation leverages on-demand transportation services to ease the burden of non-emergency medical transportation.

Intermountain (Salt Lake City) through its Healthcare Transformation Lab has launched Castell to help providers, payers and other stakeholders transition to value-based care, building on Intermountain's preventive primary-care model as well as other best practices. It will provide analytics software and other digital technology to address virtual care, patient experience and social determinants of health; manage affiliated networks; and offer access to Intermountain's latest initiatives.

Children's Hospital of Philadelphia launched Haystack Informatics, a digital health startup whose technology monitors activity log data from hospitals' electronic health records, analyzing how they're used, identifying anomalous activity patterns and spotlighting areas where the EHR can be better optimized. It was acquired by Iatric Systems, which itself was acquired by Harris Healthcare in summer 2018.

Before explaining the development approach needed to be successful in biohealth as part of the HRBRC implementation plan, it is important to consider the findings from an analysis of Hampton Roads assets that points to the value of a biohealth development approach.

Key Findings from Assessment of Assets and Population Health Needs

Among the key findings from the detailed analysis of the Hampton Roads biomedical cluster, its specific assets and population health needs informing the guidance to pursue a "biohealth" development approach are:

While biohealth research – spanning biological sciences, medical and health sciences – is a leading area of academic research, publications and patent innovation for the Hampton Roads region, it is not a large research base overall and has been declining in recent years.

- With $46.7 million in research funding in 2017, biohealth academic research stands as the region's largest area of academic research, edging out the $43.8 million generated in atmospheric, ocean and geosciences. Still this is a low level compared to many regions seeking to advance biomedical development even in Virginia and it has been declining since 2010 when it had reached $63 million. By comparison, biohealth research rose by 25% nationally from 2010 to 2017.

- Biohealth research is also one of the leading areas of peer-reviewed publications for academic institutions in the region, representing 5 of the top 10 publication fields. These leading biohealth publication fields are in surgery, obstetrics & gynecology, biochemistry & molecular biology, neurosciences and public, environmental & occupational health. Of these leading biohealth. Still only obstetrics & gynecology among these five leading biohealth publication fields stand out in its level of specialization in regional publications compared to the nation, with a 76% higher concentration in the region than in the nation.

- Biohealth also has a presence but is not the leading area of new patent innovations taking place in the region, generating 298 patent applications and awards from 2015 to mid-2019, or 15% of the total patent applications and awards across all technology areas. ODU and EVMS represent two of the largest three generators of biohealth patents, with LifeNet Health, a non-profit biohealth organization, also standing among the top three.

The potential for growth in non-clinical bioscience industry is promising, but the strength today in the region's biohealth sector is found in the hospital-based sub-sector. The non-clinical bioscience industry in Hampton Roads is undersized with a small employment base of just 2,233 jobs in the region. One bright spot in non-clinical bioscience industry development for the region is commercial research, testing and medical laboratories which grew by 46.2% from 2010 to 2018, well-outpacing the national growth of 30.1%. Still, with 1,161 jobs in 2018, commercial research, testing and medical labs is well undersized compared to that industry's employment concentration across the nation.

The sizable and fast-growing industry sector for Hampton Roads in biohealth is the hospital sub-sector, led by Sentara. Employment in the hospital sector reached 21,865 in 2018, which is 90% of the average national industry concentration of total private sector employment, and has been growing faster than the nation since 2010 -- 14.6% in Hampton Roads compared to 9.1% nationally. If these trends continue, then the hospital sector can become an industry specialization leveraging its clini-

cal excellence to attract patients from outside of the region, and making it at least a partially traded industry bringing new income into the region.

A closer examination finds that what distinguishes the Hampton Roads research efforts in biohealth is its focus on applied research rather than basic biological sciences research. Nearly 60% of the region's fifty-four active research grants in biohealth were for advancing technologies and clinical research rather than basic scientific research activities. In addition, the region is active as a site for clinical trials tapping into its healthcare infrastructure as well as clinical excellence in deploying leading technologies and innovations for clinical care, both led by Sentara Health.

Clinical trials activities also suggest a more applied approach to biohealth found in the region. As a site for clinical trials, the Hampton Roads region is quite active with 849 active clinical trials as of August 2019. The region, though, is more a participant than a leader in clinical trials, being a sponsor or collaborator in the management of only 25 active clinical trials out of the 849 being available in the region. Typically, the Hampton Roads region is participating in later stage clinical trials that involve large patient populations needed before the final regulatory approval of a new drug or device is determined.

This focus on applied research also came through in the identification of the biohealth technology-focused assets found in the region, which included applied research areas of:

- **Health delivery improvement** – This reflects the strong culture and execution found in Sentara in continuous improvements and evidence-based approaches to healthcare delivery, including defined processes for identifying best practices known as blue-printing, systemwide processes for standardizing care and use of electronic health records to identify opportunities for improvements. In 2018, Sentara reported a number of positive metrics from these efforts, including reduce readmissions, lower 30-day inpatient mortality and increases in the flow of patients through emergency and hospital stays.

- **Simulation, Learning and Gaming** – EVMS through its Sentara Center for Simulation and Immersive Learning is involved in medical education as well as research into educational technologies with over 85 external customers, while Sentara's use of simulation focuses on training nurses on new protocols and standards. While not limited to healthcare, ODU through its Virginia Modeling, Analytics and Simulation Center has a world-class capability in simulation that is actively tapped by DoD and other clients.

- **Digital health** -- Existing digital health activities involving: ongoing initiatives to tap use of electronic health record systems at Sentara and EVMS, including the Health Analytics and Delivery Sciences Institute; ODU's School of Nursing active role in telemedicine funded by DHHS Health Resources and Services Administration; Sentara-ODU collaboration in the use of blockchain technology for cybersecurity related to medical devices. Plus, Sentara is involved in several consortiums involved in Digital Health, including a blockchain consortium with IBM, a Cloud Security Healthcare Platform with EPIC and Microsoft and AVIA Innovator Network. Major opportunity to leverage strong interest from ODU's Virginia Modeling, Analysis and Simulation Center (VMASC) to establish a health systems engineering initiative to bring forward its software, data analysis and cyber-physical system/IoT capabilities to address unmet clinical needs.

- **Community health** – Over ten federal research grants being generated by ODU and EVMS, including multiple awards involving substance abuse/mental health and obesity. Also, EVMS brings a strength in implementation science with significant community health program development and assessment.

- **Diagnostic tools** – Mix of opportunities to advance diagnostic technologies involving identification of biomarkers using proteomics/mass spec, single cell imaging, biosensors, ultrasound imaging and neuroimaging. Active number of research grants involving diagnostics, including four from NIH and three from NSF across EVMS and ODU.

Complementing these more applied research assets are additional assets in a few basic research-oriented fields of bioelectrics, regenerative medicine and, an emerging area, neuro-regulation:

- **Bioelectrics** – Represents a unique research field at ODU that explores the application of electromagnetic fields to biological systems, including biological response of living cells to pulse electric fields. Its applications are far-ranging: cancer tumor eradication, micro-fluidic devices, gene delivery, and wound healing, among others. Currently five active NIH grants and two NSF grants are associated with ODU's Center for Bioelectrics.

- **Regenerative Medicine** -- At ODU, there is a group of translational focused basic researchers advancing stem cell bioengineering to advance applications primarily in regenerative medicine, with four active NIH grants. The bioelectrics capabilities at ODU can also be applied to regenerative medicine for wound repair using platelet rich plasma and delivery of growth factors. This is an area with strong industry representation from LifeNet, which has established an Institute of Regenerative Medicine with a focus on new medical applications for allograft and tissue engineering, as well as a recent ODU startup, Embody, focused on implantable devices for soft tissue restoration and regeneration.

- **Neuro-regulation:** EVMS has established an inter-disciplinary neuro-regulation group, examining how brain function links to other organ systems, including immune/inflammatory diseases. Brings together many of the NIH funded PIs at EVMS across sleep/behavior and neurofunction with basic immunology and molecular biology researchers. Examine questions such as how sleep effects immune response to vascular diseases, neuro-regulation of sleep and advancement of atherosclerosis.

These technology strengths are widely applied across leading areas of disease research found in the Hampton Roads region, as identified by research grants, publications, clinical trials and clinical excellence, as summarized in Figure 2.

One notable disease research area associated with the region's strong position in publications in obstetrics & gynecology, which also has strong assets in applied research and development, is EVMS's efforts in Reproductive, Fetal and Maternal Health. There are 4 active NIH grants in this area and a long-standing relationship with the USAID on contraceptive devices for disease prevention, through CONRAD an EVMS product development group of 50+ interdisciplinary researchers with abilities in product design, pre-clinical studies, regulatory and quality control and a dedicated clinical research center. An expert panel of Ob/Gyn leaders from Northwestern, Columbia University, and the University of Texas noted the strengths and opportunity to build upon this strength in Reproductive, Fetal and Maternal Health more broadly into a strong Women's Health program.

A strategic complement to the existing and emerging biomedical applied research focus in the region is the strong presence in university research activities of computer and computational sciences, led by ODU. Among the notable findings are:

- $13.6 million found in computer and computational sciences funding found in the region
- Strong presence in top publication fields, with five of the top ten – so all of the top ten being between biohealth and computer/com-

Figure 2. Connections between Diseases Area Assets and Technology Focus Assets

Technolgy Focus Areas / Disease Area	Bioelectrics	Diagnostic Tools	Community HEalth	Digital Health	Health Delivery Improvement	Regenerative Sciences	Simulation, Learning & Gaming
Cancer							
Cardiovascular							
Diabetes							
Neurology							
Pediatrics							
Reproductive, Fetal, & Maternal Health							
Substance Abuse							

putational fields. This includes information systems, mathematics, interdisciplinary computer sciences applications, applied math and software engineering.

ODU VMASC's national stature including its recent selection to be a member of the Systems Engineering Research Center (SERC), a University Affiliated Research Center (UARC) competitively awarded by the U.S. Department of Defense.

The leading disease areas of research also represent key areas of population health needs in the Hampton Roads region. Based on a TEConomy Analysis of data available through the Greater Hampton Roads Community Indicators Dashboard, the following areas show profound population health needs:[5]

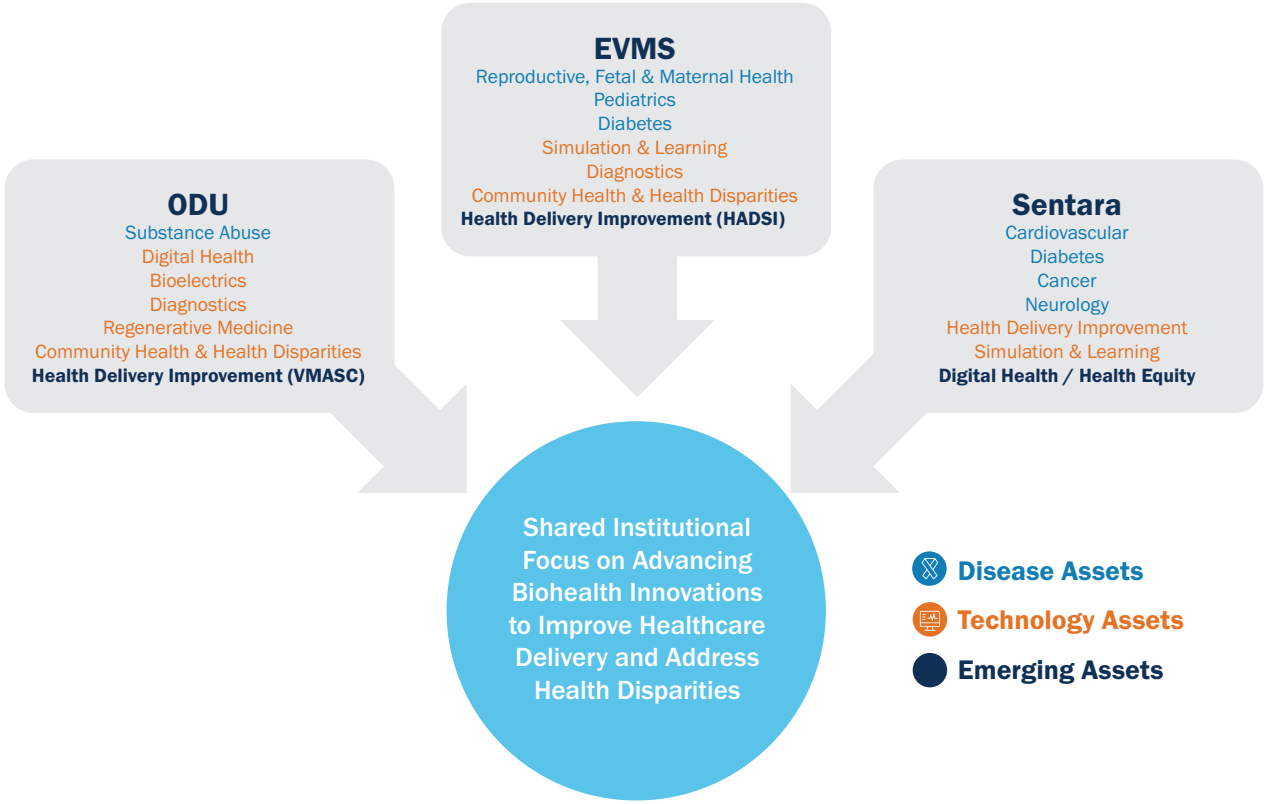
- **Cancer:** Nearly three-quarters of Hampton Roads' population lives in a city/county where the cancer incidence is in the bottom 50th percentile among all U.S. counties.
- **Cardiovascular:** More than three-quarters of Hampton Roads' population (77.7 percent) lives in an area where the age-adjusted hospitalization rate for heart failure are in the bottom quartile of Virginia counties. Throughout Hampton Roads, there are notable racial disparities in the hospitalization rate due to heart failure.
- **Diabetes:** Nearly two-thirds (65.0 percent) of the region's population lives in a county where Medicare diabetes rates are in the bottom half of U.S. counties.
- **Neurology:** Stroke rates among Medicare beneficiaries are elevated throughout the region, with 95 percent of the population living in a county where stroke rates were in the worst 50th percentile of U.S. counties.

5 *For the purposes of this study, "Hampton Roads" is defined by 14-counties in Virginia (in order of population): Virginia Beach; Norfolk; Chesapeake; Newport News; Hampton; Portsmouth; Suffolk; James City; York; Gloucester; Isle of Wight; Williamsburg; Poquoson; and, Mathews.*

- **Reproductive, Fetal and Maternal:** Nearly one-in-10 of babies (9.5 percent) born in the median Hampton Roads county had a low birthweight. On average, the share of Black babies born with low birthweight is more than twice the rate for white babies throughout Hampton Roads.
- **Pediatrics:** The vast majority of Hampton Roads' population lives in a county where hospitalization rates for pediatric mental health are in the worst quartile of Virginia Counties.
- **Substance Abuse:** The heroin-related emergency department visit rate was 18.4 visits per 100,000 population in the median Hampton Roads county, compared to 8.1 visits per 100,000 population in the median Virginia county.

This situational assessment brings to light that the Hampton Roads region is well-oriented in its assets to pursue a biohealth development pathway rather than a traditional biomedical development approach. Figure 3 below highlights the asset areas where each of the Consortium members plays a major role and has emerging efforts underway. What is shared across each is a focus on applied research, health delivery improvement and community health & health disparities.

Figure 3. Summary of Consortium Member's Major Roles in Disease and Technology Assets for Hampton Roads and Shared Interests



Shared Institutional Focus Among EVMS, Sentara and ODU Confirms Interest in Pursuing a Biohealth Development Pathway for Realizing the Goals of HRBRC

Based on the more than 50 interviews with administrators and research leaders from across EVMS, ODU and Sentara, there is a strong convergence in their assessment of their strengths and interests. Each of the participating HR institutions bring a shared focus on advancing more applied research in biohealth innovations to improve health delivery and address health disparities, which can be achieved by pursuing a biohealth development pathway.

A high level summary of each Consortium member's assets and interests point to these converging interests in applied research and health disparities:

EVMS:

- Existing applied research interests in reproductive, fetal and maternal health, pediatrics, community health, diabetes, simulation and immersive learning and cancer molecular diagnostics (proteomics)
- Institutional commitment to growing its capacities in health care delivery science
- Significant population health and health disparities efforts involving pediatrics and substance abuse

Sentara:

- Continual focus on process improvements and execution for clinical excellence
- Nationally ranked in recent years for clinical care excellence in cardiology, diabetes & endocrinology and nephrology as well as high performing in cancer, gastroenterology, geriatrics, urology, & orthopedics.
- Active in healthcare innovations involving digital health
- Active as a site for clinical trials though typically not a sponsor or collaborator
- Institutional commitment to health equity

ODU:

- Existing applied research interests in digital health (telemedicine), bioelectrics, substance abuse, community health and stem cell biology applications
- Leadership commitment to deepen its efforts to leverage strength in VMASC for health systems engineering applying expertise in computational modeling and simulation, data analytics and cyber-physical systems
- Substance abuse is active area of health disparities research

The common focus that emerges for the Consortium is advancing innovations through improved healthcare delivery and addressing health disparities that leads to commercialization of new products and formation of new ventures.

IMPLEMENTATION PLAN

The Hampton Roads region is well-positioned to play an active role in advancing a biohealth development pathway that will result in both significant new economic development benefits from innovations developed through applied research and in targeting health disparities and other priority areas for improved healthcare delivery and outcomes.

In conceiving of the implementation plan for HRBRC, it is important to recognize that the collaboration of EVMS, Sentara and ODU to pursue a biohealth development pathway will take years to perfect and build out all of its needed capacities. The proposed implementation plan addresses this reality by offering a staged approach to launching the HRBRC.

Key components of the implementation plan set out below include:

1. Explaining the value creation model in which a biohealth development pathway generates biohealth innovations informed by health analytics to improve in health delivery and address health disparities

2. Proposed HRBRC program activities and investments required based ongoing activities in the region and gaps identified to sustain the value creation for biohealth development

3. An initial focus by HRBRC on its Medicaid population as a starting point for building out its capacities and perfecting its program activities

4. Proposed organizational structure and governance for HRBRC

5. Proposed financial plan addressing the allocation of resources by program function, addressing how cost share will be generated and setting out key performance measures that will be tracked

Key Components of a Biohealth Development Pathway Model to Create Economic and Healthcare Delivery Benefits

The best way to conceive of the biohealth development pathway is as an adaptive system that knits together through feedback loops three discrete components involving biohealth development:

- The overall healthcare system involving healthcare providers, patients and underserved population groups, community groups and insurers
- An enabling infrastructure of healthcare data exchange and health analytics
- Applied research assets found in the region that can drive innovations leading to new health products and solutions, new venture startups and industry partnerships

Figure 4 depicts the many feedback loops required for sustaining a biohealth development pathway which depends upon having what the Institute of Medicine calls a “regional learning system” of turning healthcare data into knowledge, translating that knowledge into improvements in

health diagnosis, treatment and delivery and creating new data by means of those innovations to further generate new insights and knowledge.

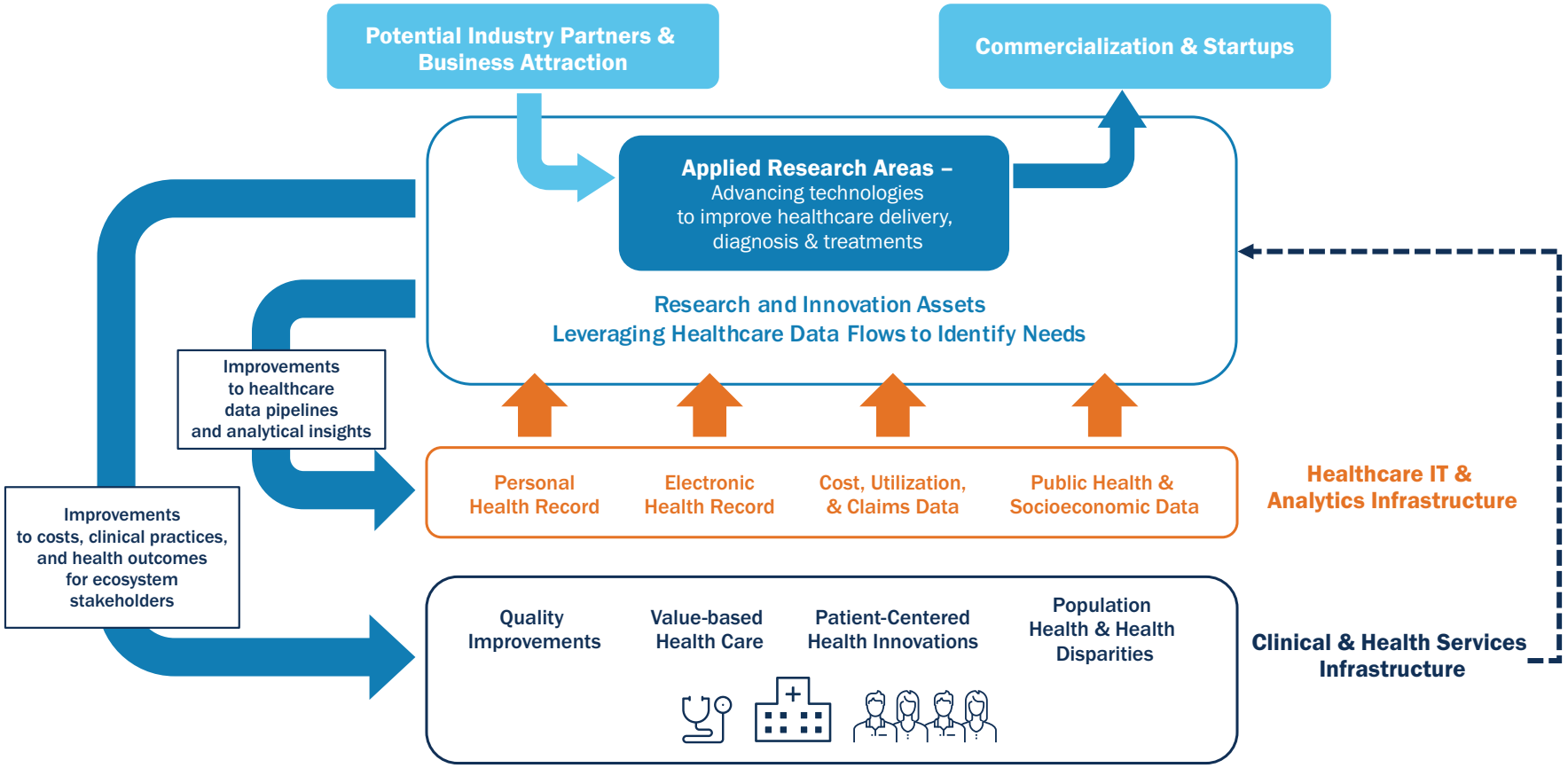
The connecting “tissue” for this value creation system is advancing the enabling infrastructure for data exchange and health analytics. Without this component, the region’s ability to guide required new solutions for applied research activities to address, nor to generate the insights to improve health care delivery. As stated earlier, analytics technology and techniques provide the insights into costs, risks and patient outcomes that improved healthcare depends upon.

In particular, addressing health disparities in a manner that provides deep insights into health outcomes requires developing a robust database to be analyzed that captures both clinical and non-clinical data on population groups, including on social determinants of health involving all of the socio-economic conditions confronting people in their lives from family situation, diet, housing, community, school, work, etc.

Once these insights into ways to improve health outcomes for specific population groups are identified, then innovative solutions involving digital health, diagnostics and treatments can be conceived, tested, deployed and, if successful, potentially commercialized as new products and potentially new ventures. Often a wide range of industry partners may be engaged to bring their capabilities in advancing solutions.

The actual process of commercialization and generating economic development benefits does not vary greatly from having to go through typical steps of ideation, customer discovery, proof-of-concept, business model development, prototyping and business launch and then business scale-up. What does vary is the focus on the health management market for solutions to improve healthcare to specific population groups facing specific health-related issues.

Figure 4. Depiction of the Components and Feedback Loops Required for Sustaining Biohealth Development Pathway



Proposed HRBRC Program Activities and Investments

Based on the biohealth development model, five key program functions have been identified for HRBRC to sustain the value creation model for biohealth development in the region. These program functions include:

- **Enabling Infrastructure for Health Data Management and Analytics** to create “data lake” from regional population data and deploy health analytics tools and services

- **Enabling Data Flows to Research Institutions** to put in place data exchange agreements among Consortium partners and associated governance, manage broader Consortium researcher access to data and ensure regulatory requirements are addressedW

- **Advancing Targeted Innovation Opportunities and Capacities** to oversee identification of targeted population health needs and health disparities to address, setting out project funding mechanisms and raising capacity of innovation areas

- **Fostering Commercialization and New Startup Formation** to move from ideation to commercialization to new product/venture development

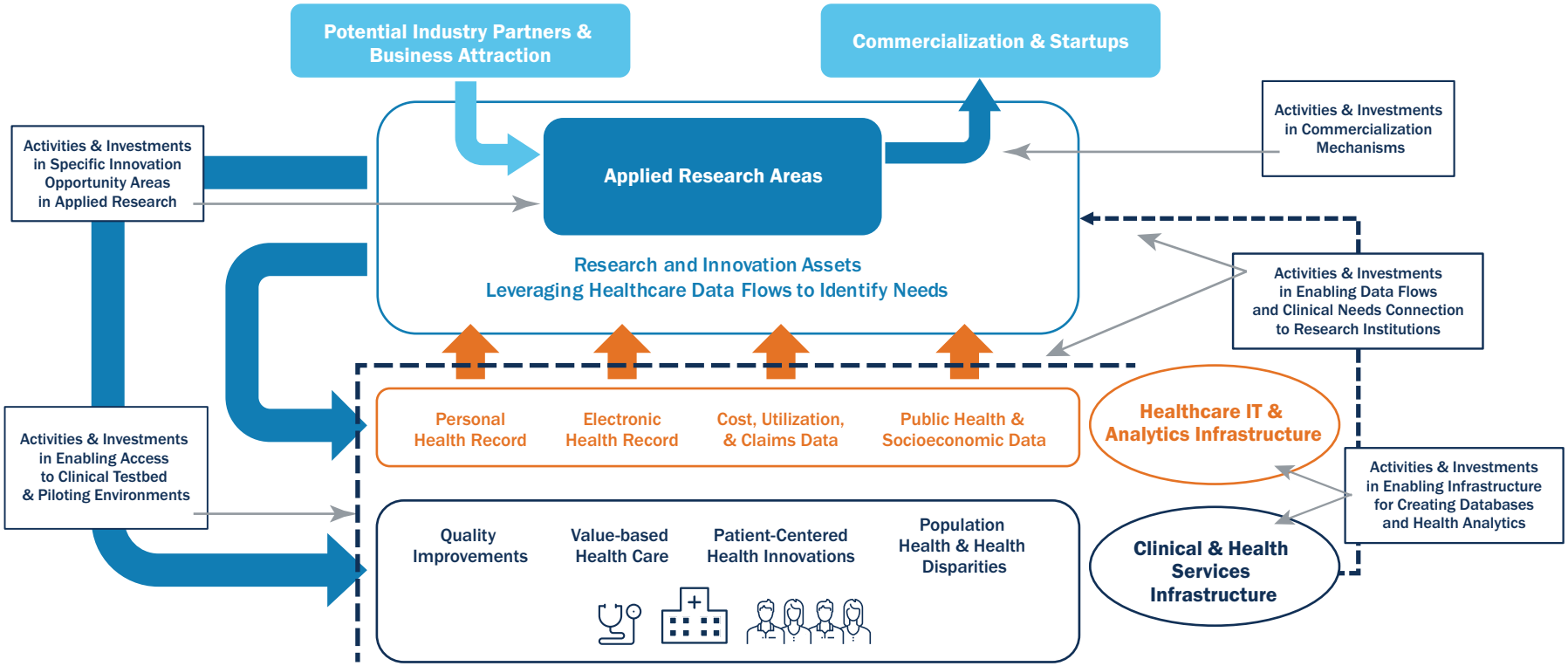
- **Providing Access to Clinical Testbed and Piloting Environments** to bring forward new innovations and practices within real-world clinical setting as well as through simulation systems

Figure 5 depicts where each of these program functions comes into play within the value creation model:

A discussion of each of these program activities follows addressing:

- What is needed from the Consortium
- What are current gaps identified from interviews
- What are potential activities and investments
- Types of Investments to be made
- Suggested operating approach

Figure 5. Depiction of Program Functions for Advancing the Biohealth Development Pathway



Establishing and Maintaining Infrastructure for Health Data Management and Analytics

WHAT IS NEEDED FROM THE CONSORTIUM

- Enabling investments to create healthcare "data lake" from regional patient populations
- Comprehensive deployment of health analytics infrastructure and systems in regional clinical settings

WHAT ARE THE CURRENT GAPS IDENTIFIED FROM INTERVIEWS

- Large back-log in accessing electronic health records for HADSI projects
- Significant investment required to convert electronic health records into data models required for data sciences insights
- Capacity needed for advancing algorithms and implementation of AI/ML to mine data
- Better leverage simulation and gaming technologies tapping human factors/behavioral science capacity to determine whether an identified innovation opportunity can be adapted into clinical practice

WHAT ARE POTENTIAL ACTIVITIES AND INVESTMENTS

- Enhancing the implementation of the Fast Health Interoperability Resources (FHIR) standard enabling a common application programming interface for patient data access with a bulk data access capability to examine patient populations and enhanced features such as inclusion of clinical notes, socio-economic data and enhanced field questionnaires
- Invest in migration of patient clinical and non-clinical data into data science models and warehousing
- Tap ODU and EVMS health analytics experts – augment with new recruitments to create a core service center that can maintain data science models and data warehousing
- Tap ODU and EVMS simulation/gaming expertise and implementation science researchers to work with Sentara – new recruitments required plus project funding

TYPES OF INVESTMENTS TO BE MADE

- Invest in migration of clinical data into data science models and warehousing
- Tap ODU and EVMS health analytics experts – augment with new recruitments to create a core service center that can maintain data science models and data warehousing

SUGGESTED OPERATING APPROACH

- Dedicated activity carried out by the formation of a Consortium organization

Benchmark Example: The Regenstrief Institute

A non-profit organization supports a data core providing a central point of access for data from the Indiana Network for Patient Care (INPC) and other specialized sources. Data Core analysts assist investigators with a mission to transform data into knowledge to improve patient care and a vision to provide efficient facilitation of research questions from inception to clinical practice. Through its Center for Biomedical Informatics, the Regenstrief Institute also has developed data analytics tools for population health that enable deep exploration of both unstructured textual data and structured discrete data to create precise patient cohorts.

Enabling Data Flows to Research Institutions

WHAT IS NEEDED FROM THE CONSORTIUM

- Data exchange agreements among Consortium partners and associated governance
- Managing broader Consortium researcher access to data … addressing priorities, conflicts, usage
- Managing regulatory requirements – who validates HIPAA compliance, de-identification and quality of datasets

WHAT ARE THE CURRENT GAPS IDENTIFIED FROM INTERVIEWS

- Not clear if HADSI has developed full set of agreements to manage requirements of researcher access between Sentara and EVMS
- ODU outside of any existing agreements and need to be incorporated

WHAT ARE POTENTIAL ACTIVITIES AND INVESTMENTS

- Oversight by Consortium Board
- Administration and regulatory compliance

TYPES OF INVESTMENTS TO BE MADE

- Operating cost for staffing administration and regulatory compliance

SUGGESTED OPERATING APPROACH

- Dedicated activity carried out by the formation of a Consortium organization

Benchmark Example: Chesapeake Regional Information System for Our Patients (CRISP)

A non-profit health information exchange serving Maryland and the broader multi-state region. Recently they advanced research as a permitted purpose for data sharing as a "secondary" component of its primary health information exchange mission. This involved advancing the governance over submission, review, approval and auditing of data for research purposes. A dedicated research subcommittee that reports to the CRISP Clinical Advisory Board manages requests and approval for data from researchers.

Advancing Targeted Innovation Opportunities and Capacities

WHAT IS NEEDED FROM THE CONSORTIUM

- Oversee identification of specific population health needs for the consortium
- Project funding tied to specific population health needs identified by consortium or promising advanced research projects in key innovation areas
- Raising capacity of innovation areas

WHAT ARE THE CURRENT GAPS IDENTIFIED FROM INTERVIEWS

- Need release time to engage physicians
- Lack of biorepositories to advance molecular diagnostics (may also be important for providing a clinical genetics data to available health information)
- Depth of existing faculty

WHAT ARE POTENTIAL ACTIVITIES AND INVESTMENTS

- Consortium affiliated panel of clinicians and researchers to leverage data for conducting annual updated of population health needs and health disparity assessments for the region
- Raise awareness of needs for innovative solutions and facilitate team-building through use of workshops
- Perhaps advance “white papers” to examine current state of technology development and potential innovation pathways and fit for commercialization/economic development – plus examine breadth and depth of existing research capacity in region
- Innovation-based project funding through a competitive grant approach – multidisciplinary teams involving Sentara-EVMS-ODU with incentive to bring in other state partners and pursue federal/philanthropic funding sources

Benchmark Example: BioNexus KC

A not-for-profit corporation formed by 10 universities, research institutes, and hospital/healthcare systems across the Kansas City bistate metro area.

BioNexus has formed inter-institutional working groups in four areas targeted to regional economic-development strategy: health IT and its link to better outcomes; animal health and its “nexus” with human health; cancer; and neuroscience. BioNexus pools funding from regional civic organizations, private foundations, and also modest dues contributions from each member of the consortium.

In addition to paying for a small staff, this pool funds a regular, peer-reviewed competition for $50,000 “research development grants” intended to better position investigators at the member institutions for federal funding and private-sector partnerships. Among outcomes reported are $10.70 in federal and private funds leveraged for each $1 invested in the research development grants

BioNexus places great emphasis on catalyzing durable IT collaborations such as:

- 1Data (the IT analogue to the “One Health” movement linking human and animal health), an interoperable database intended to facilitate animal trials that lead directly human therapies
- Creation of an IT tool to analyze health outcomes associated with a locally developed too for percutaneous coronary intervention
- An outcomes-based program to better define and diagnose autism-spectrum disorders

- Grow research capacity – perhaps matching funds for institutional faculty recruitment

TYPES OF INVESTMENTS TO BE MADE

- Need to determine a dedicated level of annual funding – might ramp up as infrastructure is completed, but cannot entirely wait for infrastructure

SUGGESTED OPERATING APPROACH

- All grant funding for targeted innovation projects done via approved processes either involving competitive process with outside reviewers or matching requirements

Fostering Commercialization and New Startup Formation

WHAT IS NEEDED FROM THE CONSORTIUM

- Lean models for customer discovery and developing business models
- Proof-of-concept funding
- New Venture Accelerator – may need to have capacity to advance commercialization and new business startup in-house as done by Accelerator Corp, Celdara Medical and VIC (virtual incubator company)
- Seed fund with ability to identify and attract entrepreneurial teams

WHAT ARE THE CURRENT GAPS IDENTIFIED FROM INTERVIEWS

- Growing efforts regionally through 757 Accelerator, but not a focus on biohealth innovations
- Virginia Beach creating a new wet lab incubator, but otherwise lacking incubator and accelerator facilities

WHAT ARE POTENTIAL ACTIVITIES AND INVESTMENTS

- Partner with existing activities to enhance biohealth commercialization and new startup formation capacities in region
- Create a dedicated "Commercialization to Startup" Seed Fund in Biohealth Innovations involving experienced entrepreneurial team to serve as entrepreneur-in-residence

TYPES OF INVESTMENTS TO BE MADE

- Advance service contracts to existing providers
- One time, ever-green investment in seed fund or structure as limited partnership with potential new funds launched as funds are subscribed (i.e. Indiana BioCrossroads)

SUGGESTED OPERATING APPROACH

- Consortium organization would contract for services in commercialization activities and would not operate the seed fund.

Benchmark Example: Consortia for Improving Medicine with Innovation & Technology (CIMIT):

Formed in the late 1990s to foster collaboration among clinicians, technologists, and entrepreneurs to accelerate innovation and catalyze the discovery, development, and implementation of innovative healthcare technologies in areas of identified unmet medical needs. CIMIT's founding members included Mass General, MIT, Brigham & Women's and Draper Labs, and has expanded to include 9 additional academic and hospital systems in the Boston area.

CIMIT established a "clinical pull" model in which an intimate understanding of unmet medical needs is the starting point and then the focus is on identifying collaborators to work on developing and advancing solutions to the problem. It is well-known for advancing a staged focus on commercialization involving: pilot and proof of concept projects proof-of-value validation to show clinical benefits commercial accelerator incubation stage projects that includes a healthcare commercialization boot camp for project teams.

It has a strong record of success since 1998 including: 600 peer-reviewed and facilitated collaborative projects undertaken; 250 solutions developed; 78 of the solutions have had a commercial exit with 87% still in the market and 61% commercialized through a start-up, 20% licensed and 19% developed with an industry collaborator who commercialized.

Providing Access to Clinical Testbed and Piloting Environments

WHAT IS NEEDED FROM THE CONSORTIUM

- Advance service contracts to existing providers
- One time, ever-green investment in seed fund or structure as limited partnership with potential new funds launched as funds are subscribed (i.e. Indiana BioCrossroads)

WHAT ARE THE CURRENT GAPS IDENTIFIED FROM INTERVIEWS

- Lack of infrastructure for pragmatic clinical trials
- Broaden capacity to use systems simulation capabilities for lower cost "virtual" testing

WHAT ARE POTENTIAL ACTIVITIES AND INVESTMENTS

- Prototype facilities – may be able to leverage ODU facilities around VMASC
- Simulation/gaming testbed facility – build off existing EVMS and ODU facilities … includes Sentara Center for Simulation and Immersive Learning at EVMS, ODU VMASC + Telehealth
- Clinical research capacity – how to advance development of pragmatic clinical trials … does CONRAD offer capacity … need biostatisticians, improved consenting and clinical research coordinators/staff

TYPES OF INVESTMENTS TO BE MADE

- Consortium can help in establishing and providing ongoing support that is either matched increasingly over time or reduced over time as supported by other grant activities over time

SUGGESTED OPERATING APPROACH

- Consortium organization would contract for creating a core facilities

Benchmark Example: Baystate Health's TechSpring

Launched in 2014, TechSpring is a digital innovation center that offers technology companies access to the health system and its employees. One important goal is to attract biohealth startups from the Boston metro 90 miles westward to Springfield and simultaneously to expose the region to venture investors also based in Boston.

As a "living lab," the laboratory enables companies to test and validate digital health technologies — such as patient monitoring applications and medical record solutions — within an authentic healthcare environment that faithfully replicates the complete "software stack" in use at the Bay State Medical Center and its regional clinical practice affiliates, but also isolated from daily operations and HIPAA-protected information.

Through 2018, 30 projects have been undertaken. Two early-stage companies involved in projects with TechSpring have been acquired, one by Athena Health and the other by Allscripts

Initial Focus for HRBRC: Addressing Health Disparities for Hampton Road's Medicaid Population

As a starting point for HRBRC, the Consortium members have identified addressing the health disparities found among the region's Medicaid population. With the recent expansion of Medicaid in Virginia, this is a timely focus to better integrate and address the needs of this growing patient population, including more parents and single adults who are now entering the state's health care system.

Given Medicaid's role in serving people with complex clinical, behavioral health and social needs, it calls for the type of rich database of both clinical and non-clinical data on social determinants of health that HRBRC will be looking to create across the region, and is of critical importance for HRBRC to demonstrate its commitment to health equity and addressing health disparities and the burden of poor health on the poor in the region.

As the Institute for Medicaid Innovation explains in its 2019 report, Innovation and Opportunities to Address Social Determinants of Health in Medicaid Managed Care:

> "The complex relationships between social determinants and health result in inequities in care and outcomes, with greater burden of major disease, disability and mortality. Although social determinants affect all individuals to varying degrees, low-income individuals, as well as those of certain racial and ethnic groups, are disproportionally affected."[6](page 1-2)

From examples around the nation, a wide range of innovative solutions may be identified once the specific understanding of how social determinants and health issues interact for Medicaid populations as well as making in-roads into ways to improve the development and ongoing maintenance of the enriched clinical and social determinants database:[7]

- Developing analytics to address identification issues for Medicaid patients who do not have strong attachment or engagement with a regular set of providers
- Improving population-wide analytics and visualization tools for seeing the patterns across different population groups facing specific socio-economic conditions and health issues on a neighborhood by neighborhood basis
- Advancing identification of social vulnerability of Medicaid patients based on changing conditions they are facing
- Creating a Community Resource Hub to connect patients to needed community resources and to allow healthcare providers to issue electronic referrals for patients to community resources
- Capturing insights from patient conversations that aren't codified within electronic health records
- Developing tablet-based data collection methods for home care visits
- Advancing a pediatric asthma management program that increased awareness of the effectiveness of anti-inflammatory drugs and medical adherence
- Improved monitoring approaches for congestive heart failure
- Improved care coordination methods, including transition of care services from hospital based to home care services

In tackling the Medicaid population, HRBRC will seek to focus on particular subgroups of Medicaid populations based on strategic insights

6 *Institute for Medicaid Innovation, Innovation and Opportunities to Address Social Determinants of Health in Medicaid Managed Care, January 2019, pages 1-2*

7 *Draws on examples set out in variety of articles and reports, including from Health Analytics, "Using Health IT to Meet Medicaid Population Health, Socioeconomic Needs," April 20, 2018; Center for Health Care Strategies, Measuring Social Determinants of Health among Medicaid Beneficiaries: Early State Lessons, December 2016;*

gathered from the use of health analytics. The Center for Children and Families at Georgetown University explains: "Large disparities can be found among pockets of population that live short distances from each other. For instance, the average life expectancy for babies born to mothers in New Orleans can vary by as much as 25 years across neighborhoods just a few miles apart."[8]

The Institute for Medicaid Innovation offers examples of how different subgroups within the Medicaid population might be affected by different health and social needs, including:[9]

- **Elderly:** Likely to have complex health needs and be affected by multiple chronic conditions, cognitive disability and social isolation and require long-term care services and supports. The care needed by these elderly Medicaid patients may extend beyond clinical care and include activities of daily living such as bathing and eating.

- **Children in Foster Care System:** Children in the foster care system have a variety of social risk factors – including abuse, household substance use disorders, and poor living conditions. They are more likely to have behavioral health disorders, developmental challenges, and chronic health conditions. This social and health context requires coordination across multiple agencies and organizations to meet a complex host of needs.

- **Chronically Homeless:** Chronic homelessness is associated with increased risk of communicable diseases, environmental exposures, mental health disorders, asthma, and other poor health outcomes. Chronic homelessness is linked to high utilization of clinical services and increased incidence of mortality

- **Formerly Incarcerated Individuals:** Individuals who have been involved in the justice system are often affected by substance use disorders, chronic health conditions, and mental and behavioral health challenges.22 These risk factors, along with others such as educational attainment, housing instability, and unemployment, require clinical and community integration strategies.

A strong community-based participatory health approach is required by HRBRC to work with the Medicaid population as the focus for launching HRBRC's approach to build up its capacities within the enabling data and health analytics infrastructure and to perfect its approaches to linking insights to innovative biohealth solutions. Key principles for community-based participatory research, include:[10]

- **Long term commitment** to developing and maintaining trusting relationships of value to the communities. Ongoing communication and support for capacity building within the community is essential.

- **Cultural sensitivity** ensuring that the beliefs, customs, laws and other aspects unique to special populations and communities are respected and incorporated into any project on an ongoing basis.

- **A true partnership** involving the community in all phases of the project with an active, ongoing dialogue as the project is implemented. Community input into project design, implementation, data

8 *Georgetown University Center for Children and Families, Leveraging Medicaid to Address Social Determinants of Health and Improve Child and Population Health, February 2018, page 6*

9 *Institute for Medicaid Innovation, op. cit., page 3*

10 *See the following for deeper discussion on CBPR: Examining Community-Institutional Partnerships for Prevention Research. Report of Findings and Recommendations. January 2004 CDC Prevention Research Center. Community-Based Participatory Research for Health. Minkler M, Wallerstein N. (eds). Jossey-Bass, 2003.*

analysis and communication of results is essential to successful research projects.

- **Sufficient funding** for completion of the project and with focus appropriate to the needs of the community in sustaining solutions that are proving successful.

Moving forward, HRBRC will seek to establish through a dedicated advisory group, who will be involved in the development, analysis and implementation of its database development and innovation programs addressing the health and socioeconomic needs of Medicaid recipients. This will represent a collaborative partnership approach to research that involves community organizations, experts in community health and Medicaid from the Consortium members, insurance companies involved in Medicaid managed care in Hampton Roads, community philanthropic organizations and local public health agencies. The partners contribute their expertise to enhance understanding of a given problem, and "facilitate approaches for effectively translating community-based interventions in public health and prevention into widespread practice at the community level."[11]

Based on interviews with leading faculty involved in community health, who already work closely with Medicaid populations in the Hampton Roads region, there are strong partnerships that have been developed with key community stakeholders involved with the Medicaid population and may offer initial starting points for focusing work with specific subgroups of the Medicaid population for HRBRC. These subgroups of Medicaid population include:

- Medicaid population living in public housing projects across the region
- Children receiving Medicaid who are in school
- Pregnant women receiving Medicaid
- Teenagers receiving Medicaid who are vulnerable to substance abuse
- Rural Medicaid population

11 *Examining Community-Institutional Partnerships for Prevention Research. Report of Findings and Recommendations. January 2004 CDC Prevention Research Center.*

Proposed Organizational Structure and Governance of HRBRC

Following the dictate of "form following function" the organizational structure and governance of HRBRC recommended includes:

Recommended Organizational Structure: Form a non-profit 501c3 corporation

Rationale:

- Since the Consortium will have operational roles in data management/health analytics infrastructure, data exchange oversight and management of other applied research, commercialization contracts and clinical testbed and pilot facility contracts it is important that it be managed as an independent organization
- Independent organizational form will also ensure accountability for activities and address potential conflicts of interest

Recommended Governance: A non-profit board that includes a majority of Consortium members, but also has broader representation of biosciences business leaders and community health advocates

Rationale:

- Consortium members will be required to drive the cost share and generation of matching dollars and so should have a majority voice in overseeing the organization
- Still, a broader range of stakeholders needs to help guide the Consortium with a focus on its two outcome related goals of advancing economic development and addressing health disparities and broader population health needs
- As part of the governance structure, HRBRC will make use of specific advisory groups, such as in the case of the Medicaid Population Initiative. An advisory group can be charged with helping to guide the direction and specific projects undertaken within an initiative, under the broad oversight by the HRBRC board.

Recommended Operations: Lean staff with active use of performance based contracts with resources in the community

- A full-time President/CEO will be recruited to guide the day-to-day management and strategic directions of HRBRC, and will have a position on the Board of the non-profit organization. The President/CEO should have considerable experience in leading projects or building coalitions and consortium that cut across academia, health care and business. The person must bring an understanding from direct experience in healthcare management and/or health IT, applied research and commercialization. This person should have management experience with entrepreneurial organizations that seek partnerships, whether in non-profit or for-profit sectors.

    - Recruitment of the President/CEO shall begin as soon as the Plan is approved by the legislature. Each of the Consortium members should make their initial appointments to the Board, designate interim officers, and initiate the search process while filling the remaining positions on the Board of Directors. The intent should be to have the full Board in place prior to completion of the selection process. In the period between the formation of the new non-profit entity and successful recruitment of a permanent President/CEO, an interim director knowledgeable of the issues of starting such a non-profit entity should be hired to assist in forming the non-profit and recruiting a permanent President/CEO. This person could begin the organizational work of HRBRC and might serve as the secretariat to the search committee for the permanent President/CEO.

- No more than 10% of the total funding raised by HRBRC should go towards administration and operations, including the operations of

the data exchange, the management of competitive review processes for project funding and the development and management of outsourcing contracts for commercialization services.

Recommended IP Role: HRBRC to have an upside from IP and commercialization activities, but not a direct management role

Rationale:

- The Consortium is not expected to have the expertise to manage IP or commercialization
- Still the Consortium has an interest in participating in "upside" events from IP or commercialization it has helped to fund

Strategies for Cost Sharing and Initial 5 Year Plan for Resource Allocation

Under the requirements of the legislation establishing the HRBRC, cost sharing strategies between and among the partnering institutions and entities to include matching requirements need to be identified.

Annual cost share will come from a variety of sources, including:

- Foregone indirect costs contributed by EVMS and ODU for dedicated faculty, equipment and facility use, as well as from other university partners.
- In-kind contributions from Sentara for staff, physician time and data access
- Cash contributions from participating institutions, industry partners and community organizations, including philanthropic organizations and individual gifts
- Access fees for approved uses of databases developed
- Support from federal research grants (subcontracts)

These cost sharing strategies are closely linked to how HRBRC will allocate funding. While it is not expected that cost sharing will be measured on strict a program function by function basis, it is expected that through participation in the program functions Consortium members will be involved in generating cost share.

Table 1: Cost Share Strategies by Program Function

Program Function	Cost Share Strategy
Establishing and maintaining the data and health analytics infrastructure	Indirect costs contributed by EVMS and ODU that are associated with: • Dedicated faculty and research staff working to establish the data and analytics infrastructure • Software license acquisition • Facility use Sentara will provide in-kind contributions of staff time to establish the data and analytics infrastructure
Managing the Data Exchange to Researchers and Others	Access fees from use of databases developed (outside organizations, federal grants, etc.)
Advancing Targeted Innovation Opportunities and Capacities	Indirect costs contributed by EVMS and ODU that are associated with dedicated faculty and research staff working on approved projects In-kind contributions from Sentara of release time for physicians to participate in approved projects
Fostering Commercialization and New Startup Formation	Funds raised by participation in “upside” events from IP or commercialization
Providing Access to Clinical Testbed and Piloting Environments	Access fees from use of facilities by outside organizations, federal grants, etc.

Initial 5-Year Proposed Resource Allocation Plan

The chart below sets out the expected allocation of resources associated with HRBRC. The state's initial allocation of $4 million of General funds and $10 million in capital resources for FY 2020 is an important start for HRBRC, but continued state support will be needed. It is estimated that continued state support of $4 million in General funds and $10 million in capital funds will continue. This would result in total state funding over the five years of $70 million, of which $20 million will come from General funds and $50 million in capital funds.

Table 2. Rationale and Potential Level of Resource Allocation by Program Function for HRBRC

Program Function	Rationale for Resource Allocation	Potential Level of Resource Allocation
Administrative and operations of new organizational entity	No more than 10% of state funding	Years 1-5: 10%
Establishing and maintaining the data and health analytics infrastructure	It is expected that the upfront costs will be higher to establish the infrastructure involving facility improvements, data servers, software licenses and data setup and migration costs. After this initial setup period, expect to reach a steady state thereafter.	Years 1-3: 30% Years 4-5: 20%
Managing the Data Exchange to Researchers and Others	Part of the 10% of overall operations and administration	Not applicable
Advancing Targeted Innovation Opportunities and Capacities	Seek to offer a consistent level of funding for projects and matching funds for startup costs to attract key faculty	Years 1-5: 35%
Fostering Commercialization and New Startup Formation	Ensure a consistent level of funding for commercialization and entrepreneurial support services for biohealth development. All investment resources will be privately funded	Years 1-5: 5%
Providing Access to Clinical Testbed and Piloting Environments	Limited in initial years while data and analytics infrastructure are established and then ramp up in later years using capital resources	Years 1-3: 5% Years 4-5: 25%

Performance Measures

An important responsibility of the new HRBRC organization to be formed will be to track its performance.

A very standard and accepted approach to program evaluation is the use of a "logic model" to represent program operations and outcomes. The logic model is widely used as a tool in assessing the implementation of a newly formed initiative by modeling how a program is intended to work (the "logic" of the initiative) and allowing for measures along the way to ensure that each step is occurring as planned. As the Kellogg Foundation explains in its Logic Model Development Guide, "the purpose of a logic model is to provide stakeholders with a road map describing the sequence of related events connecting the need for the planned program with the program's desired results."[12]

The power of the logic model is its focus of how a program operates and how the expects to produce results. Two particularly important types of performance measures emerge from the use of a logic model approach:

- ***Outputs*** are the direct products of program activities and may include types, levels and targets of services to be delivered by the program.
- ***Outcomes*** are the specific changes in external measures that suggest the ultimate success of a program. For HRBRC, this would include economic development measures and health measures.

In the early years of HRBRC, there are not expected to be much in the way of outcomes realized, so outputs are of particular significance to ensure that the program efforts of HRBRC are successful.

The text box below sets out an initial set of performance measures that HRBRC will be tracking and reporting on annually.

12 *W.K. Kellogg Foundation Logic Model Development Guide, January 2004, page 3, available at www.wkkf.org.*

Initial Performance Measures to be Tracked by HRBRC

Output measures from program activities:

- Number of applied research projects using data exchange
- Commercialization projects underway tracking key milestones – ideation, patents, new business start-ups, joint industry projects
- New health service offerings – patients served, patient satisfaction, improved health outcomes, etc

Outcome measures from program activities:

- Leverage in generating grant and investment funds
- Regional jobs generated from applied research, technology services, new venture startups and industry partnerships in the region
- Improved health for population subgroups assisted

Next Steps: Illustrative Timeline of Key Annual Objectives

The Plan set out is only as good as its implementation. Below is a high-level illustrative timeline of key objectives to be accomplished over first five years)

YEAR ONE OBJECTIVES:

- Approval by the General Assembly of the HRBRC Plan and release of funds
- Establish the organizational form with an interim President drawn from the consortium and set out the data exchange and innovation activity policies and procedures
- Initiate the development of the health data and analytics infrastructure with a priority on Medicaid population
- Form a Medicaid advisory workgroup and set out a broad approach to its applied research efforts to guide data analytics
- Identify key enhancements for EVMS and ODU in applied research assets

YEAR TWO OBJECTIVES:

- Complete the health data and analytics infrastructure
- Solicit and award initial applied research projects for addressing population health needs and disparities for Medicaid population
- Recruit and select a Permanent President/CEO
- Generate new research partnerships with health analytics and digital health industry partners

YEAR THREE OBJECTIVES:

- Seek federal and philanthropic sources of funding based on initial results of first round of research project and broader leveraging of the Medicaid population database and health analytics capabilities
- Form a health analytics/digital health accelerator leveraging health data and analytics infrastructure and access to applied research assets
- Advance new biohealth innovations for technology development, proof-of-concept and clinical testing
- Attract teams of industry partners to co-locate in the region

YEAR FOUR OBJECTIVES:

- Receive federal and philanthropic awards
- Implement new innovations in population health management for Medicaid based on advancements from research projects
- Initiate commercialization of innovations
- Root new entrepreneurial teams in the region

YEAR FIVE OBJECTIVES:

- Demonstrate tangible results in:
  - Improved population health outcomes from clinical testing and ramping up full implementation
  - Attracting significant base of research funding from federal and philanthropic sources
  - Advancing innovation-based economic development by attracting established industry partners to region, entrepreneurial teams in health analytics and digital health and commercialization of new innovations into startup companies

APPENDIX A

Position of Hampton Roads in Biomedical Development and Mapping of its Assets

Prepared in Development of Proposed Strategic Plan Guiding
the Establishment of a Hampton Roads Biomedical Research Consortium

INTRODUCTION

This Appendix to the proposed strategic plan for the Hampton Roads Biohealth Research Consortium provides a situational assessment of the Hampton Roads position in overall biomedical development, including a mapping of its assets.

As way of background, in the 2019 legislative session, Virginia's General Assembly called for the establishment of the Hampton Roads Biomedical Research Consortium (HRBRC), with initial funding of $4 million in general funds and $10 million in capital funds for FY20. This is a substantial step for advancing and catalyzing an emerging research and innovation-led economic driver in the region, while also addressing the region's significant unmet health needs and disparities that serves as a barrier to further economic growth and prosperity of the Hampton Roads region.

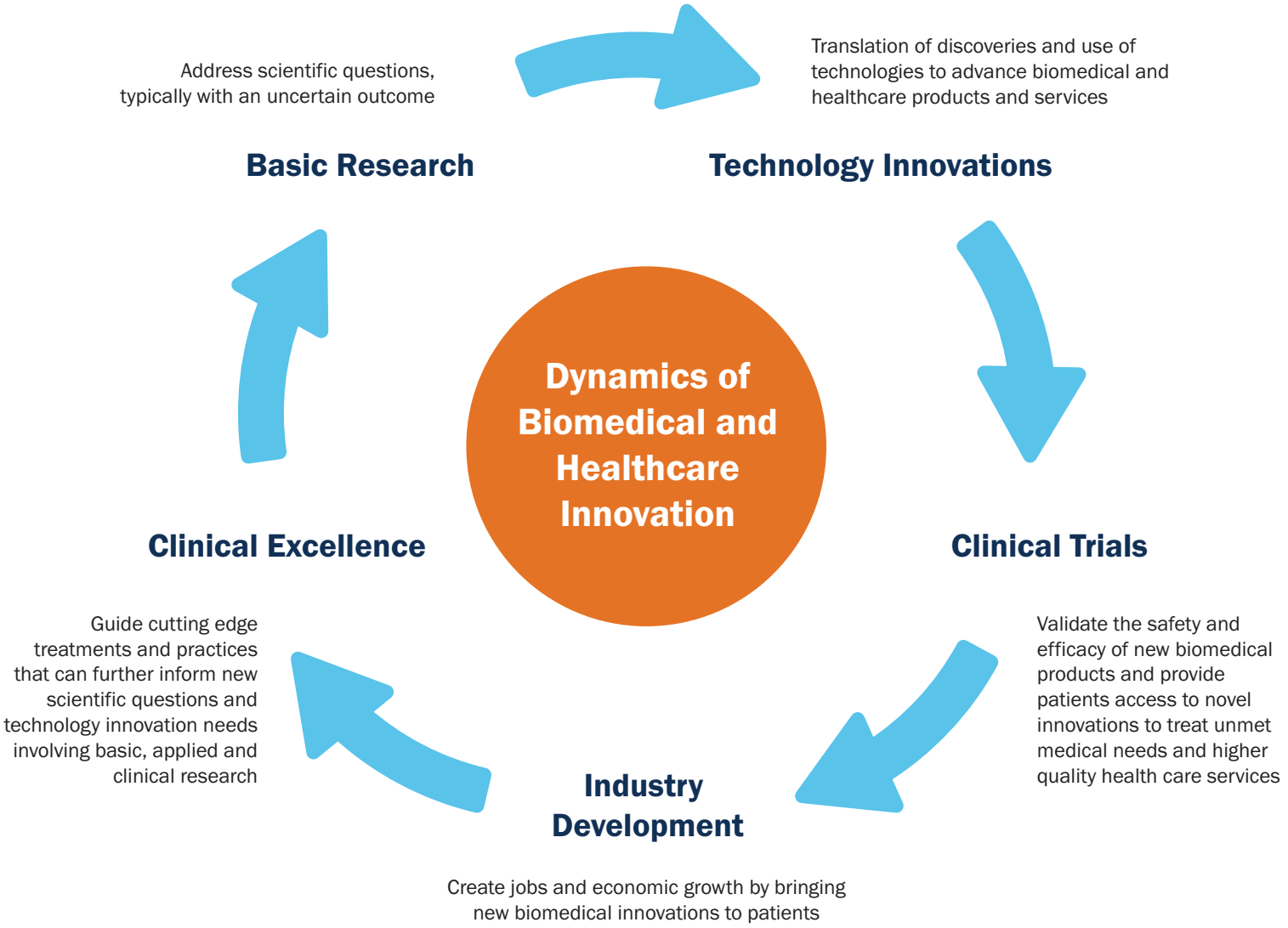
In calling for a "plan to identify areas of research relevant to the region taking into account the region's biomedical public and private assets," the General Assembly recognized that biomedical development stands apart from other technology sectors in the close relationship between basic and clinical research activities, found largely at universities and academic medical centers, and the significant efforts required to advance new product development, from continued research to regulatory approval to market acceptance performed by industry. An extensive study in the late 1990s found that 31 percent of new drugs and medical products would not have been developed (or would have been substantially delayed) in the absence of academic research, more than twice the rate found for all technology industries.[1] Indeed, the fast pace of basic research advances found in biomedicine with the advent of fields such as biotechnology, genomics and population health sciences is reshaping the way we study medicine, discover and develop therapeutics, and diagnose and treat diseases and medical conditions.

As specified by the General Assembly in its appropriation of funds for the HRBRC, a Work Group of regional organizations was formed to guide the HRBC Strategic Plan, under the coordination and facilitation of the University of Virginia. This Work Group retained the services of TEConomy Partners, LLC., a leading national technology-based economic development organization with significant expertise and experience in advancing biosciences roadmap for more than 30 states and regions across the U.S. Over the 2017-2019 period, TEConomy assisted the Virginia Research Investment Committee in its comprehensive assessment of the Commonwealth's research assets across industry, universities and federal labs located in the state, entitled Assessment of Virginia's Research Assets: Strategic Directions to Advance Innovation-led Growth and High-Quality Job Creation across the Commonwealth (the "Report") and implementation planning. In addition, TEConomy recently worked with the Virginia Growth and Opportunity Board to conduct entrepreneurial assessments for each of the nine GO Virginia regions, including Region 5 covering Hampton Roads.

To assess Hampton Road's position in biomedical development and its specific assets to build upon, a comprehensive biomedical innovation ecosystem approach, recognizing the close connections between biomedical research and clinical/healthcare activities, was utilized as depicted in Figure A-1.

1 *Edwin Mansfield, Academic Research and Industrial Innovation, Research Policy, 1998, 26: 773-776.*

Figure A-1. Framework for Assessing Regional Biomedical and Healthcare



The TEConomy project team analyzed data across each of the key elements of the biomedical innovation ecosystem that drive development, including:

Research Activities:

- Research expenditures across academic institutions in the region, including EVMS and ODU
- Peer-reviewed publications by field by universities, federal labs and health systems, including EVMS, ODU and Sentara
- Competitive biomedical-related research grants from federal agencies taking place in the region, funded by NIH, NSF and other federal agencies

Technology Development Activities:

- Biomedical-related patent innovations by inventors residing in the region, by area of technology focus and assignees
- Identified active biomedical companies involved in innovation activities in the region

Clinical Trials:

- Active clinical trials taking place in the region, by phases, disease areas and leadership roles, based on clinicaltrails.gov

Industry Trends:

- Using BIO's comprehensive definition of biosciences sub-sectors, examined level of employment, employment growth and regional specialization

Clinical Excellence:

- Examined rankings from U.S. News and World Report on hospital rankings in recent years across clinical specialities and procedures

In addition, the team conducted extensive interviews with more than 50 interviews with administrators and research leaders from across EVMS, ODU and Sentara, as well as discussions with biomedical industry and economic development officials in the region to better understand the situation for biomedical development, details on specific assets and insights into growth opportunities and viable strategic interventions (see Table 1 for a listing of those interviewed by organization).

Table A-1. Listing by Organization of Those Interviewed for the Development of the HRBRC Plan (Ryan and Jonathan need to review)

EVMS:

- Alfred Abuhamad, Chair, Ob/Gyn
- David Archer, Director, Jones Institute for Reproductive Medicine
- Bob Armstrong, Director, Corporate Relations
- L.D. Britt, Chair, Surgery
- Richard Britton, Professor
- Mr. Brant Cox, VP and Chief Operating Officer
- Paul DiMarco, Director of Technology Transfer
- Sunita Dodani, Director, HADSI
- Gustavo Doncel, Director, CONRAD
- Elena Galkina, Professor
- Clarence (CW) Gowan, Chair, Pediatrics
- Richard Homan, President
- Cynthia Kelly, Professor of Pediatrics
- Woong-Ki Kim, Professor
- Jerry Pepe, Chair, Physiological Sciences
- Andrew Plunk, Professor, Division of Community Health
- Larry Sanford, Professor
- John Semmes, Director, Cancer Center, Associate Dean, Translational Sciences
- Elias Siraj, Director, Diabetes Center
- Andrea Thurman, Clinical Director, CONRAD
- William Wasilenko, Vice Dean of Research

- Laurie Wellman, Biorepository Director
- Eric Werner, CHKD Medical Director of Clinical Research

Sentara:

- Cynthia Allen, Corporate VP, Oncology Program Development
- Jordan Asher, SVP and Chief Physician Executive
- Tyler Bennett, VP Orthopedic Service Line
- John Brush, Cardiology Specialists
- Carolyn Carpenter, President, Norfolk General Hospital
- Audrey Douglas-Cooke, VP, Patient Care Services, Sentara, Heart Hospital
- Terrie Edwards, Corporate VP, Peninsula/Western Tidewater
- Alex Grunsfeld, Clinical Chief, Neurology (Heart Hospital)
- Grace Hines, Corporate VP, System Integration
- Halthy Hochmiller, Simulation Learning Center
- Kurt Hofelich, Corporae VP, Ambulatory Services
- Thomas Klevan, Medical Director, Cardiac Service
- Iris Lundy, Director, Health Equity
- Genemarie McGee, Corporate VP & Chief Nursing Officer
- Cindy Parker, Director, Systemwide Clinical Education
- Michael Reagin, SVP and Chief Information and Innovation Officer
- David Torgerson, VP, Enterprise Analytics
- David Woolwine, Corporate VP, Learning and Organizational Development

ODU:

- Austin Agho, Provost and Vice President for Academic Affairs
- Muge Akpinar-Elci, Chair, Community & Environmental Health
- Tom Allen, Professor
- Joshua Behr, Professor, VMASC
- Dayle Daines, Associate Dean, College of Sciences
- Siaku Diallo, Research Director, VMASC
- Morris Foster, Vice President of Research
- Hadiza Galadima, Assistant Professor, Community and Environmental Health
- Nancy Grden, Executive Director, Strome Entrepreneurial Center
- Khan Iftekharuddin, Professor and Associate Dean for Research and Graduate Programs, College of Engineering
- Karen Karlowicz, Chair, School of Nursing
- Michelle Kelley, Chair, Psychology
- Ravi Mukkamala, Chair, Computer Science
- Harold Riethman, Medical Diagnoc and Translational Sciences
- Sachin Shetty, Professor, Computer Sciences/VMASC
- Gymama Slaughter, Director, Bioelectrics Center
- Jeff Tanner, Dean, Strome College of Business
- Eric Weisel, Director, Virginia Modeling, Analytics and Simulation Center
- Christian Zemlin, Associate Professor, Electrical and Computer Engineering

Industry and Economic Development:

- Taylor Adams, Virginia Beach DED
- Jeff Conroy, Embody
- Deborah DiCroce, Hampton Roads Community Foundation
- Steve Harrison, VP, Business Intelligence, HR Economic Development Alliance
- Laura Hayes, Virginia Beach DED
- Kerry McCarter, Realta Life Sciences
- Pjerin Luli, Dilon Technologies
- Richard Severinghaus, CTN Solutions
- Randolph Wojcik, Ray Visions

SETTING THE CONTEXT:

ASSESSING HAMPTON ROAD'S BIOMEDICAL DEVELOPMENT POSITION

Hampton Roads is an emerging region in biomedical development, with sufficient levels of activities across research, technology development, clinical trials, industry development and clinical excellence to advance an innovation-led approach for future biomedical development.

The region's development position points in a direction that emphasizes more applied biomedical research activities linked to converging technologies in computer and computational sciences and focused around heathcare improvements. The chart below summarizes the position of the Hampton Roads region in the key drivers of biomedical development.

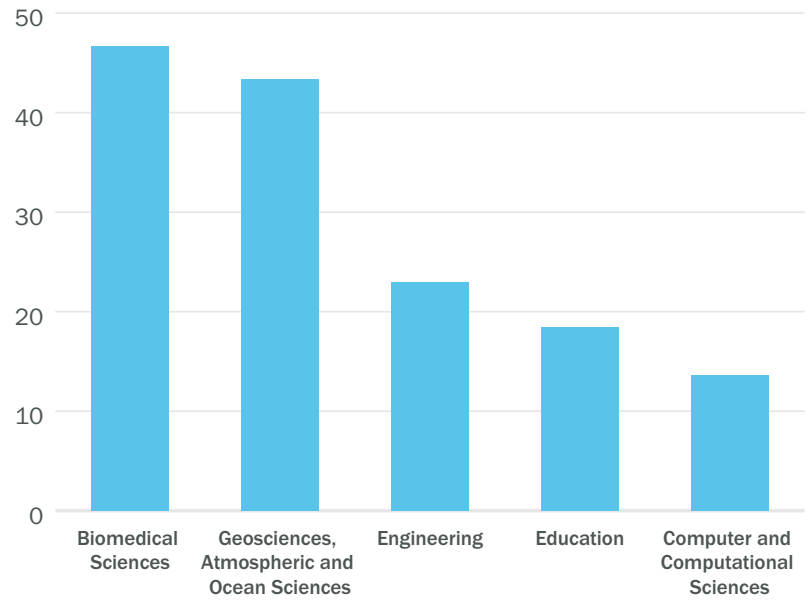
Table A-2: Summary Assessment of Key Drivers of Biomedical Development in Hampton Roads

Driver	Summary Assessment
Research:	• Largest field of academic research funding • But at $46 million in 2017, this level of research activity is low compared to many regions seeking to advance biomedical development • Plus, biological and biomedical sciences have been declining since 2010, and just flat in health sciences • Biohealth research along with computer and computational sciences make up the top ten areas of peer-reviewed publications in the region – each with five of the top ten fields. • Federal grants – few in basic research, predominantly in technology development/clinical research
Technology Innovations:	• With nearly 300 biomedical-related patent applications and awards generated by Hampton Roads inventors since 2015, there is a sizable base of technology innovation found in the region • ODU and EVMS represent two of the largest three generators of biohealth patents, with LifeNet Health, a non-profit biohealth organization, also standing among the top three. • Patents dominated by medical and surgical fields
Clinical Trials:	• Typically serve as a site for later phase trials • Few trials with sponsorship or collaborators, except for pediatrics and reproductive/fetal/maternal health
Industry Development:	• Sizable industry base led by Hospitals employment with modest base in industrial life sciences; region is emerging, however with recent growth that has outpaced nation. • Among innovation-led biomedical companies, while LifeNet is the region's great success story, there is a growing base of health IT/digital health companies being formed
Clinical Excellence:	• Sentara Norfolk General nationally ranked and high performing in numerous specialty areas

Research Activities

In academic research expenditures for Hampton Roads, biomedical stands as the region's largest area of academic research. At $47 million in research funding in 2017, biomedical academic research edges out the $43.8 million generated in atmospheric, ocean and geosciences. EVMS at $28 million and ODU at $13 million comprise 90% of this biomedical-related research funding taking place in Hampton Roads – with no other academic institution generating more than a little over $2 million in biomedical-related research.

Figure A-2. Major Fields of Academic Research in Hampton Roads, 2017 ($ millions)

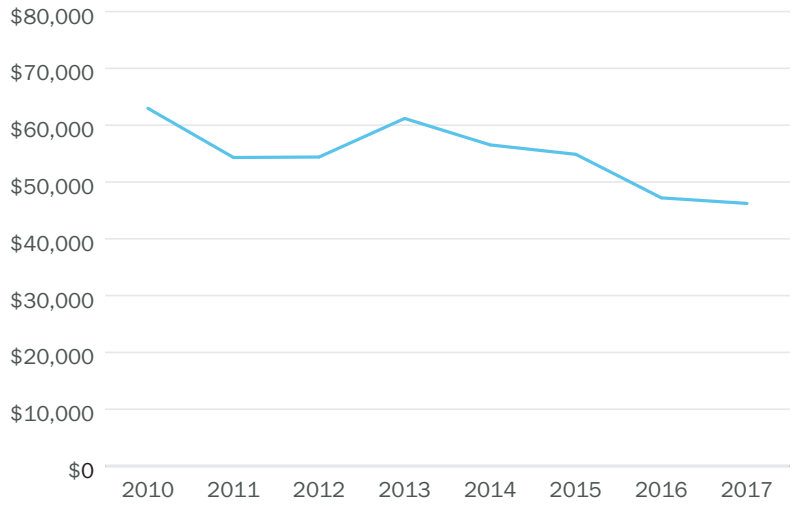


Source: National Science Foundation Higher Education Research and Development (HERD) Survey, analysis by TEConomy

Still this is a low level of research compared to many regions seeking to advance biomedical development even in Virginia – where UVA had over $300 million in 2017 and Virginia Tech/Carilion had just over $95 million.

Of greater concern is that overall biomedical academic research spending in Hampton Roads has been in sharp decline since 2010 across Hampton Roads, when it had reached $63 million. By comparison, biohealth research rose by 25% nationally from 2010 to 2017.

Figure A-3. Trends in Academic Biomedical Research in Hampton Roads, 2010-2017, ($ thousands)



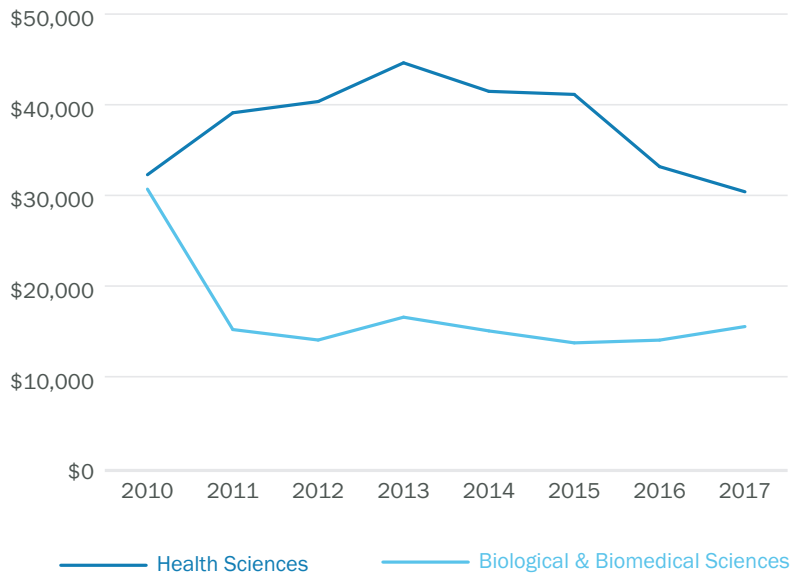
Source: National Science Foundation Higher Education Research and Development (HERD) Survey, analysis by TEConomy

A closer examination finds that within biomedical research, the strength of Hampton Roads is found in Health Sciences research, involving clinical medicine, public health, nursing and more allied health fields. This more applied area of health sciences research activity compared to basic

biological/medical sciences, represents just over $30 million of the $47 million overall in funding, or nearly 65% of total biomedical research in the region.

In recent years the sharp decline found in overall biomedical research is clearly being driven by the fall-off in basic science-related biological/medical sciences. Health sciences held its own over the period and actually had years of higher levels of funding than in 2010.

Figure A-4. Trends in Academic Basic Biological/Medical Sciences and Applied Health Sciences in Hampton Roads, 2010-2017, ($ thousands)



Source: National Science Foundation Higher Education Research and Development (HERD) Survey, analysis by TEConomy

In peer-reviewed publications, which is another measure of scholarly activity taking place at academic institutions, biomedical research stands as one of the leading areas publications in the region. As Table A-2 below reflects, biomedical publication fields comprise 5 of the top 10 publication fields. These leading biomedical publication fields are: surgery, obstetrics & gynecology, biochemistry & molecular biology, neurosciences and public, environmental & occupational health. Of these leading biomedical fields, however, only obstetrics & gynecology among these five leading biohealth publication fields stand out in its level of specialization in regional publications compared to the nation, with a 76% higher concentration in the region than in the nation.

Computer and computational sciences is the other leading area of scholarly activity reflected in the top peer-reviewed publication fields for Hampton Roads. Among the top ten fields of peer-reviewed publications are information systems, mathematics, interdisciplinary computer sciences applications, applied math and software engineering. So, all of the top ten publication fields for academic institutions are found either in biomedical or computer/computational fields. In computer sciences, ODU is by far the leading university in the region, with more than 80% of the peer-reviewed publications.

This strength in computer/computational sciences offers a strategic complement to the existing and emerging biomedical applied research focus in the region since it can advance areas such as digital health, health analytics and simulation/modeling.

Table A-3. Listing of Top Ten Peer Reviewed Publication Fields Across Academic Institutions in Hampton Roads, 2016-2019 (mid-year), Publications and Publication Specialization

Discipline Area	Total Hampton Roads Institution Pubs	Publications Activity Specialization Index
Surgery	205	0.97
Computer Science, Information Systems	202	2.19
Mathematics	162	2.40
Obstetrics & Gynecology	157	1.76
Biochemistry & Molecular Biology	155	0.66
Computer Science, Interdisciplinary Applications	147	2.22
Neurosciences	137	0.56
Mathematics, Applied	135	2.30
Computer Science, Software Engineering	124	2.79
Public, Environmental & Occupational Health	109	0.77

Another way to examine biomedical research taking place in Hampton Roads is through federally-funded research grants. Most of these federally-funded research grants are awarded on a competitive basis, and so reflect research strengths found in the region. Fifty-four active research grants involved in biomedical research were identified across federal agencies. The two leading federal agencies funding 49 out of the 55 active awards was the National Institutes of Health, with 39 awards, and the National Science Foundation, with 10 active awards.

A more detailed review of these 55 active awards suggests that 32 involve more applied technology development efforts and 22 are more focused on basic sciences, tracking with the general emphasis in research funding (see listing in Tables A-3 and A-4).

Table A-4. Listing of Active Biomedical Research Awards Identified, by Basic and Applied Research Focus

22 Basic Research Grants	
• Structure of the Prepowerstroke Conformation Of Actomyosin-adp-pi By Time-resolved Cryo-em • B Cell Anergy, Modified LDL Uptake, And Atherosclerosis • Myeloid Cell-specific Role Of STAT4 In Atherosclerosis And Metabolic Dysfunction • Targeting Brain Macrophage Reservoirs Of SIV During HAART • Anaplasma Phagocytophilum Modulate Tick Gene Expression For Its Survival And Transmission From The Vector Host • PIC1 Inhibition Of Myeloperoxidase Activity And Inflammation • Tuning Of Innate Immunity In Local Lung • Limbic Modulation Of Stress-induced Alterations In Sleep • Molecular Modeling Of The Activity And Inhibition Of The Thryoid Enzyme Iodothyronine Deiodinase • Multi-resolution Docking Methods For Electron Microscopy • Mechanoregulation Of Nascent And Mature E-cadherin Adhesions • Antidotes Against Mustard-induced Chronic Lung Injury	• Antidotes Against Hydrochloric Acid-induced Chronic Lung Injury • Peptide Inhibitors Of Oxidative Heme Toxicity In Acute Hemolysis • High Throughput Screening To Discover Novel Toxin Inhibitors Relevant To The Treatment Of Otitis Media • Synthesis And Study Of Glycoconjugates And Carbohydrate Based Macrocycles • Collaborative Research: Kinetic To Continuum Modeling Of Active Anisotropic Fluids • Collaborative Research: Efficient High-order Algorithms For Nonequilibrium Microflows Over The Entire Range Of Knudsen Number • Collaborative Research: Sparse Optimization In Large Scale Data Processing: A Multiscale Proximity Approach • Psma Glycosylation And Aggressive Prostate Cancer Progression • Extracellular Vesicles Mirnas As Mediators Of Sleep Fragmentation Effects On Diabetes And Liver Disease Progression • Impairment Of Certain Neurocognitive Tasks (Spatial Memory And Executive Function-attentional Set Shifting) Following Exposure To Low Hze Doses

Table A-5. Listing of Active Biomedical Research Awards Identified, by Basic and Applied Research Focus

32 Applied Research Grants Advancing Technologies and Clinical Research	
• Development Of Protein Biomarkers In Post-dre Urine For Use In Liquid Biopsy Of Prostate Cancer • The Abscopal Effect Of Nanosecond Electric Pulse Tumor Ablation And Its Enhancement For Metastatic Breast Cancer • Dna-specific Pattern Recognition Receptor Activation Following DNA Electroporation • Efficient Delivery Of Plasmid DNA To Achieve Appropriate Transgene Expression	• Cctn - Contraceptive Clinical Trial Network - Female Sites • Cctn-pharmacokinetic/Pharmacodynamic Evaluation Of Levonorgestrel Butanoate For Female Contraception • Adolescent Marijuana Use And Marijuana Possession Arrests: Have Changes In Marijuana Policy Affected Disparities Between Blacks And Whites? • Refining Boosters To Strengthen Online College Student Drinking Interventions • Efficacy And Mechanisms Of Technology-based Behavioral Interventions • Alcohol Use, Relationship Factors, Minority Stress, And Psychological Well-being: A Daily Process Examination Among Young Adult Females

32 Applied Research Grants Advancing Technologies and Clinical Research

- Quantitative Image Modeling For Brain Tumor Analysis And Tracking
- New Photostable Nanoprobes For Real-time Imaging Of Single Live Cells
- Low Energy Defibrillation With Nanosecond Pulsed Electric Field
- Photostable Multiplexing Nanoassays For Real-time Study Of Embryonic Stem Cells
- Examining Binge Eating In Daily Life: Working Toward Reducing Obesity Disparities In Racially Diverse Lesbian And Heterosexual Women
- Thermal Assisted Gene Electro Transfer To The Skin
- Controlled Delivery Of Plasmid DNA Via Low-temperature Ion Deposition
- A Three Dimensional Bioprinting Approach To Mapping Critical Determinants Of Stem Cell Asymmetric Divisions
- Spatial Eco-epidemiology Of Tick-borne Rickettisal Pathogens
- Food Assistance, Diet And Body Weight Status Among WIC Eligible Children
- Novel Tools For The Noninvasive Evaluation Of The Human Placenta
- Project Horizon: Hydrogel Injectable Depot System For Next-generation Long-acting HIV Prevention And Contraception
- Causes And Health Consequences Of Synthetic Drug Abuse
- Nets: Small: Large-scale Opportunistic Data Crowdsourcing And Dissemination In Device-to-device (D2D) Networks
- EAGER: Non-invasive Monitoring Of Arterial Parameters Via Model-based Analysis Of Arterial Pulse Signals Measured By A Microfluidic-based Tactile Sensor
- Collaborative: A Mobile Smart Glucose Monitoring System
- A Non-invasive And Cost-effective Sputum Assay For Lung Cancer Screening
- CAREER: A Self-powered Biosensing Microsystem
- BRAIN EAGER: New Tools For Real-time Imaging Of Molecular-resolution Connectomics Of Synapses
- Microbicides Round 4 - Conrad Objective 2
- Early Detection Of Tumor Relapse In Triple-negative Breast Cancer
- Implementing A Social-ecological Suicide Prevention Program (Sespp) At Old Dominion University

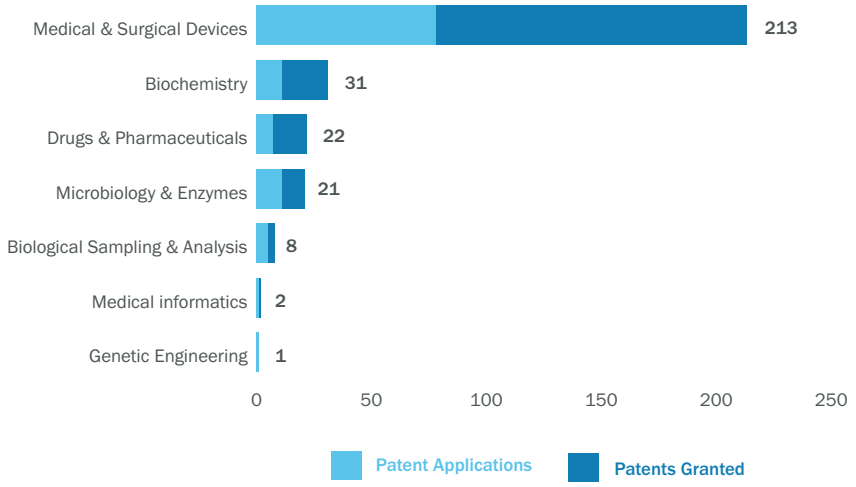
Technology Development

For biomedical development a well-accepted measure of technology development is patent innovations. Patents represent the intellectual property owned by companies and research institutions. In biomedical development, patents is the primary way that companies and research institutions protect the innovations generated through their technology development efforts from being replicated.

Biomedical development is a significant, though not leading area of patent innovations taking place in the region. Patent applications and awards invented by residents of Hampton Roads reached 298 from 2015 to mid-2019, or 15% of the total patent applications and awards across all technology areas in the region.

The key fields for patent innovations in Hampton Roads is overwhelmingly found in medical and surgical devices. This reflects a more applied engineering focus to patent innovation in biomedical development in the region compared to areas like drugs & pharmaceuticals, which often involve advances in basic biological sciences.

Figure A-5. Biomedical Patent Innovation in Hampton Roads, by Broad Technology Segment, 2015-2019 (mid-year)



Source: US PTO data from Carivate Analytics' Derwent Innovation patent analysis database, analysis by TEConomy

ODU and EVMS represent two of the largest three generators of biohealth patents, with LifeNet Health, a non-profit biohealth organization, also standing among the top three. Table A-5 sets out the number of patents and the primary technology segments that they fall within by the top assignees in the region.

Table A-6. Top Assignees of Biomedical Patent Innovation in Hampton Roads, by Broad Technology Segment, 2015-2019 (mid-year)

Local Patent Assignee	Patents (Applications + Granted)	Primary Technology Innovation Segments
LifeNet Health	24	Biochemistry; Medical & Surgical Devices
Old Dominion University Research Foundation	21	Medical & Surgical Devices
Eastern Virginia Medical School	15	Medical & Surgical Devices; Biochemistry
Hampton University	6	Medical & Surgical Devices
ReAlta Life Sciences	4	Biochemistry; Drugs & Pharmaceuticals

Clinical Trials

A unique challenge for biomedical development is the need for multiple phases of clinical testing in humans to demonstrate the safety and efficacy under strict FDA regulatory oversight of investigational therapeutics as well as novel types of devices. The Tufts Center for the Study of Drug Development reports that clinical trials are becoming both more science-driven and complex, requiring significantly more eligibility criteria, procedures and overall work burden. For these more scientifically challenging and complex clinical trials, academic medical centers and academic hospitals offer the deep insights of physician-researchers to help in leading clinical trials, sites that offer more scientific capabilities across its staff and equipment, and a rich environment for recruiting patients.[2]

A total of 849 active clinical trials were identified as taking place in the Hampton Roads region based on an analysis of FDA's clinicaltrials.gov website. The vast majority were for interventional clinical trials advancing novel drugs or medical devices. The leading disease areas for clinical trials activity in Hampton Roads is in oncology trials with 305, followed by pediatrics with 219, cardiovascular with 109 and women's health.

Still not all clinical trials are the same. There are multiple rounds of clinical trials that need to take place, with the early phase clinical trials typically involving thought leaders able to guide new advances in medical innovations through initial Phase I safety testing and Phase II efficacy testing and ultimately helping to inform the protocol for larger scale randomized testing in Phase III.

Hampton Roads tends to be primarily involved in the more "site" driven Phase 3 clinical trials involving recruitment of large number of patients for randomized, control testing across most disease areas, (Phase 3) and post-approval monitoring of safety and long-term side effects. While there are disease areas that are more active in early phase trials relative to total interventional trials – such as women's health, pediatrics, oncology and central nervous system/neurology – the strength reflected in the clinical trials activities is to recruit patients as a site (see table A-6).

2 *See Tufts Center for the Study of Drug Development, "Rising protocol complexity is hindering study performance, cost, and efficiency: Impact Report," July 17, 2018)*

Table A-7. Active Clinical Trials in Hampton Roads Region, as of end of August 2019, by Phase and Disease Area

Disease Area	Interventional Trials by Phase							Observational Trials	Observational – Patient Registry Trials	Total Trials
	N/A	Phase 1	Phase 1/ Phase 2	Phase 2	Phase 2/ Phase 3	Phase 3	Phase 4			
Total, all trials	110	19	18	172	19	365	34	89	23	849
Oncology	9	10	17	79	7	141	5	32	5	305
Respiratory	4	2	4	10	4	39	1	4	3	71
Cardiovascular	50	0	0	5	2	28	6	13	5	109
Metabolic	3	1	0	5	0	13	4	6	0	32
CNS	6	1	1	34	0	22	4	16	2	86
Infectious Disease	2	2	0	11	2	11	6	3	1	38
Hematologic	3	0	2	20	1	19	1	7	3	56
Gastrointestinal	2	0	0	11	2	28	1	6	1	51
Women's Health	10	13	0	14	4	48	4	5	0	98
Pediatrics	15	6	5	56	7	95	20	15	0	219

Source: clinicaltrials.gov, analysis by TEConomy

Another way to assess whether Hampton Roads is a thought leader in clinical trials is the extent to which they are involved as a sponsor or collaborator in the administration and analysis of results from clinical trials. Out of the 849 clinical trials, only 45 involve Hampton Roads as a sponsor and/or collaborator – so this is further confirmation of the region's role as more of a site to provide patients rather than being a leader in the clinical trials development. Two disease areas do stand out, nevertheless, with Pediatrics and Women's Health representing 28 of these 45 clinical trials where Hampton Roads is a sponsor/collaborator.

Table A-8. Active Clinical Trials where Hampton Roads Region is a Sponsor or Collaborator, as of end of August 2019

Disease Area*	Total Trials
Total, all trials	45
Oncology	5
Respiratory	4
Cardiovascular	2
Metabolic	2
CNS	2
Infectious Disease	1
Hematologic	1
Gastrointestinal	
Women's Health	12
Pediatrics	16

Biomedical Industry Development

To define biomedical industry in the Hampton Roads region, TEConomy started with the biosciences definition used by BIO and its affiliates across the nation, including VABio, and focused on just those specific industries involving biomedical activities, including drugs & pharmaceuticals, medical devices, research, testing and medical labs and biomedical-related distribution.[3] Given the high-value role of hospitals with close ties to medical schools in offering clinical excellence and regional advantage to attract outside patients, such as the relationship of EVMS and Sentara, TEConomy also examined the hospital sector as a component of biomedical industry in the Hampton Roads region.

The non-clinical biomedical industry base in Hampton Roads is undersized with a small employment base of just 2,150 jobs in the region. These non-clinical biomedical industries have been making job gains over the economic recovery, but at a much slower pace than the nation and just over half the growth of total private sector industry growth in the region. One bright spot in non-clinical bioscience industry development for the region is commercial research, testing and medical laboratories which grew by 46.2% from 2010 to 2018, well-outpacing the national growth of 30.1%. Still, with 1,161 jobs in 2018, commercial research, testing and medical labs is well undersized compared to that industry's employment concentration across the nation.

The sizable and fast-growing biomedical-related industry sector for Hampton Roads is the hospital sub-sector, led by Sentara. Employment in the hospital sector reached 21,865 in 2018, which is 90% of the average national industry concentration of total private sector employment, and has been growing faster than the nation since 2010 -- 14.6% in Hampton Roads compared to 9.1% nationally. If these trends continue, then the hospital sector can become an industry specialization leveraging its clinical excellence to attract patients from outside of the region, and making it at least a partially traded industry bringing new income into the region.

Table A-9. Biomedical-related Industry in Hampton Roads, with Employment, Location Quotient and Job-Growth from 2010-2018

Biomedical Industries by Sectors	Region Employment 2018	Region Location Quotient 2018	Region Job Change 2010–18	U.S. Job Change 2010–18
Total Private Sector	599,651	1.00	8.0%	17.3%
Total Biomedical Related (with Hospitals)	24,098	0.72	13.4%	11.6%
Non-Clinical Biomedical (without Hospitals)	2,150	0.25	4.7%	19.8%
Bioscience-related Distribution	663	0.25	-36.2%	25.9%
Drugs & Pharmaceuticals	101	0.07	43.8%	5.4%
Medical Devices & Equipment	225	0.13	49.2%	10.4%
Research, Testing, & Medical Laboratories	1,161	0.42	46.2%	30.1%
Hospitals	21,865	0.90	14.6%	9.1%

Despite this small non-clinical industry base, TEConomy was able to identify 20 innovation-led biomedical companies in the region. The most mature and significant company is LifeNet, which has over 1,000 jobs in

3 *See https://www.bio.org/sites/default/files/TEConomy_BIO_2018_Report.pdf for detailed industry definitions of the biosciences*

the region and continues to grow. It is difficult to cull out themes in either therapeutics or medical device companies forming around innovation in the region, the fact there there are nearly a dozen of them bodes well in suggesting that the region with a more intentional focus can create and have these more "product-related" biomedical companies thrive.

One area of biomedical development that may be reaching a critical mass is in health information technology/digital health. There is a growing base of such companies, including 7 Cups, Alerta, ARDX, CareFamily, EdLogics, Modio Health, RecoveryTrek and XRDA Health Solutions.

Table A-10. Innovation-led Biomedical Companies Identified in Hampton Roads Region

Company	How Identified	Description from Web; Pitchbook; SBIR and VBHRC Awards
7 Cups	VC -- Pitchbook	Provider of a technology designed to offer emotional support services. The company's technology anonymously and securely connects real people to real listeners in one-on-one chat, enabling users to get the support to maintain their emotional health and well-being.
Air Tite Products Company	Patents	Provider of hypodermic products for medical and veterinary uses.
Alerta	Strome Entrepreneurial Development Center	Innovative tracking/notification product for caregivers/people with Alzheimers
ARDX	Strome Entrepreneurial Development Center	Federal/government health care technology/IT and consulting, as well as population health
CareFamily	VC -- Pitchbook	Provider of an online senior care services marketplace created to connect caregivers with care seekers. The company's web-based platform connects care seeking senior citizens with care givers enabling care seekers and their families to save time, efforts and costs involved in hiring care providers.
Dilon Technologies	VC -- Crunchbase	Focused on delivering clinically useful imaging and intra operative systems appropriate for early disease diagnosis and surgical applications. The company operates a quality system that complies with all applicable regulations, standards and guidelines to deliver reliable technologies and products.
EdLogics	Strome Entrepreneurial Development Center; 757 Angels	Technology/game/app platform for health education
Embody	VBHRC grants	A regenerative medicine company focused on the development and commercialization of implantable medical devices to address the unmet demands in soft tissue restoration and regeneration. Leveraging our expertise in biomaterial design, biofabrication, nanotechnology, and medical devices, we are engineering implantable devices that will disrupt and significantly improve patient outcomes in soft tissue surgical applications.

Company	How Identified	Description from Web; Pitchbook; SBIR and VBHRC Awards
EOS Surfaces, LLC.	Patents	Anti-infective surface application for hospitals to protect against pathogen transmission from surfaces by actively and continuously killing 99.9% of all gram-negative and gram-positive bacteria within 2 hours of exposure.
Extinction Pharmaceuticals	VC -- Pitchbook	Operator of a drug development company. The company develops drugs for the treatment of anxiety disorders and other afflictions. The company also provides clinical trials of drugs for addiction, autism and stroke recovery.
EYERX RESEARCH, INC.	SBIR	Dedicated to developing and bringing to the commercial marketplace products that will aid vision and prevent blindness. There is an ever-increasing need for such products and EyeRx intends to benefit mankind by addressing that need; SBIR award for A Thermo-responsive Biopharmaceutical to Enhance the Tear Production of Lacritin; PROOF OF CONCEPT FOR ANTIMICROBIAL PROPERTIES OF LACRITIN IN VIVO
GLYCOMANTRA, INC.	NIH award	We are a start-up biotechnology firm leading the translational glycobiology research and interested in the development of carbohydrate-based therapeutics of cancer and fibrosis.
H&H Medical Corporation	Patents	Developer of solutions for pre-hospital trauma for first responders, including tourniquets, chest seals, surgical kits, bleed packs.
ivWatch	VC -- Pitchbook; Patents	Provider of an intravenous infiltration detector device designed to monitor the status of a patient's IV therapy to aid in the early detection of peripheral IV infiltrations. The company's monitoring device uses non-invasive sensor technology enabling clinicians, caregivers and doctors to reduce potentially serious medication dosing errors and associated patient harm from infiltration events.
JBC Corporation	Patents	Developer of custom medical kits and assemblies for use on battlefields, ships and isolated locations
LifeNet Health	VHBRC; Patents	A non-profit company involved in procurement and distribution facility for human organs, tissue grafts and bio-implants. Has established an Institute of Regenerative Medicine with a focus on new medical applications for allograft and tissue engineering. One VBHRC grant was for enhancement of healing in diabetic wounds using a decellulrized dermal matrix and a second grant was for tissue preparations for therapeutic use in cardiovascular applications
Matbock, LLC.	Patents	Defense-related product developers for battle field supplies and equipment, including medical-related products, such as surgical kits and medic bags
Modio Health	Strome Entrepreneurial Center; 757 Investors	Cloud-based tech/credentialing platform
RecoveryTrek	Strome Entrepreneurial Center	Technology-based recovery and drug monitoring for professionals/companies
XRDA Health Solutions	Strome Entrepreneurial Center	Commercial healthcare consulting/population health and disparities

Clinical Excellence

The U.S. News and World Report prepares an annual rankings of nearly 5,000 hospitals across the nation in 16 adult medical and 10 pediatric specialties. These rankings are largely driven by objective data, such as death rates for particularly challenging patients, patient experience on overall quality of hospital stay known as the Hospital Consumer Assessemnt of Healthcare Providers and Systems, and measures of performance from the American Hospital Association Annual Survey, such as nurse staffing, patient volume, certain clinically proven technologies and other measures related to quality of care. For the determination of the national rankings of the top hospitals, roughly 25% of the determination is based on experts in the 16 Best Hospitals specialties listing up to five hospitals they consider to be the best hospitals in their area of expertise for complex or difficult cases.[4] For each specialty area 50 of the top hospitals are ranked and then among those close to the top 50 a designation of high performing is provided.

Sentara's Norfolk General Hospital is one of the few hospitals across the nation to be nationally ranked by U.S. News and World Report in specialty areas in recent years and has also received high performing assessments. In the last two years, Sentara's Norfolk General Hospital has received national rankings or high performance designation in cancer, cardiology, diabetes, ear/nose/throat, GI, geriatrics, neurology, orthopedics and urology (see Table A-9 right). Sentara's Princess Anne Hospital has also received some high performance assessment in recent years for geriatrics, nephrology and pulmonology & lung surgery

Table A-11. US News and World Report Rankings for Sentara Norfolk General Hospitals, Past Two Years of Rankings, 2018-2019 and 2019-2020

Specialty	2018–2019	2019–2020
Cancer	High Performing	High Performing
Cardiology	32nd	High Performing
Diabetes & Endocrinology	31st	Not Ranked
Ear, Nose & Throat	Not Ranked	43rd
Gastroenterology & GI Surgery	High Performing	Not Ranked
Geriatrics	High Performing	Not Ranked
Nephrology	48th	High Performing
Orthopedics	High Performing	Not Ranked
Urology	High Performing	High Performing

It is also important to note that Sentara has received national recognition for the high quality of its hospital nursing care. 8 of its hospitals (out of 23 for all of Virginia) recognized by Magnet Designation for quality patient care, nursing excellence and innovations in professional nursing practice. Sentara has received numerous Beacon Awards from American Association of Critical-Care Nurses for excellence in patient care.

4 *For more details, see https://health.usnews.com/health-care/best-hospitals/articles/faq-how-and-why-we-rank-and-rate-hospitals*

Summary

The findings from reviewing the development position of the Hampton Roads biomedical assets and population health needs suggest that the Hampton Roads region has a distinct pathway for successful biomedical development that differs from many of our nation's leading biomedical regions who build upon significant strengths in basic research.

Typical of most regional biomedical development strategies is the recognition that biomedical development stands apart from other technology sectors in the close relationship between basic and clinical research activities, found largely at universities and academic medical centers, and the significant efforts required to advance new product development, from drug development and pre-clinical research to clinical trials and regulatory approval. This has led most regional biomedical strategies to focus on leveraging basic biomedical research strengths found among regional academic institutions to drive new discoveries that can be commercialized through translational "bench to bedside" research activities and lead to forming new ventures or licensing with local industry partners.

The Hampton Roads region, in contrast, has more of a focus on applied research activities from health sciences research to surgical and medical devices in patent innovation to a leading position in clinical excellence to industry strengths in healthcare delivery and a growing mass of innovation-led companies in health IT/digital health. This applied focus with its strong alignment with healthcare delivery suggests a different biomedical development path may be appropriate to Hampton Roads in what might be termed "biohealth."

The more detailed assessment of assets gives more specificity to what this might look like for Hampton Roads.

MAPPING OF HAMPTON ROADS BIOMEDICAL ASSETS

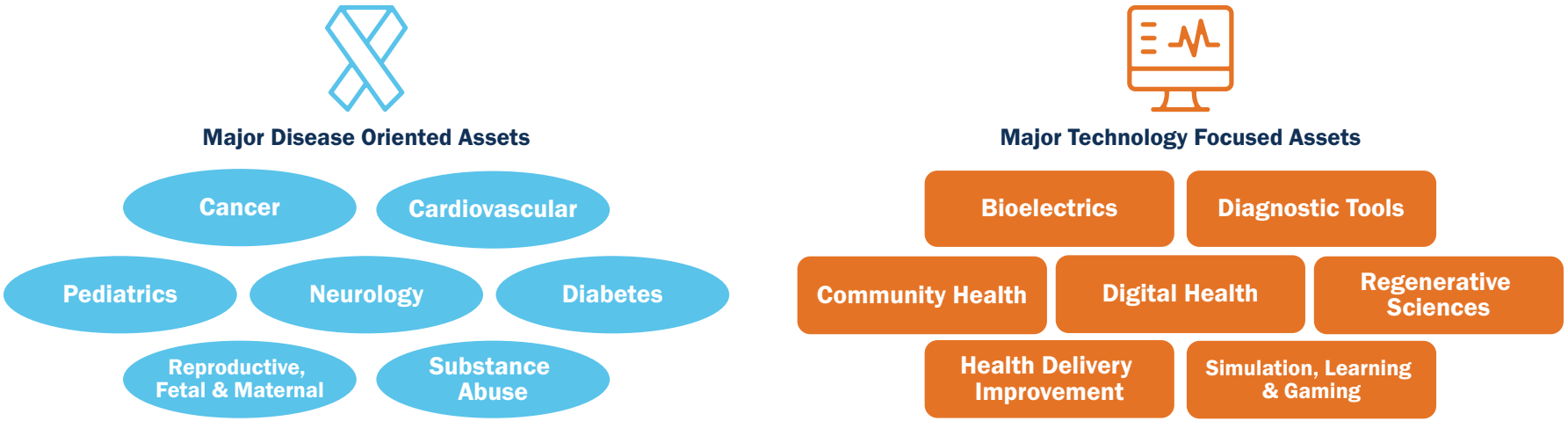
To identify the assets found in the Hampton Roads region for biomedical development, TEConomy examined the specific areas of focus across the wide range of biomedical data assembled on activities in the region, including federal grants, publications, patent activities, clinical trials, industry development and clinical excellence. This quantitative intelligence was complemented by the extensive interviews that the TEConomy project team undertook to learn more specifically about the strengths of different organizations.

Based on both the quantitative and qualitative intelligence gathered together, fourteen specific asset areas where identified, evenly split between disease assets and technology assets, as depicted in Figure A-6.

Each of these assets are explained in more detail in the asset profile summaries below that pull together the intelligence gathered into two broad categories – documented activities in the region involving specific data points and activities and qualitative insights provided through interviews.

Across these assets there is considerable alignment among the founding HRBRC members – EVMS, Sentara and ODU. Based on the quantitative intelligence from the data analysis and the qualitative intelligence from more than 50 interviews with administrators and research leaders from across

Figure A-6. Biomedical Assets Identified in Hampton Roads, by Disease Assets and Technology Assets



EVMS, ODU and Sentara, there is a strong convergence in their assessment of their strengths and interests. Each of the participating HR institutions bring a shared focus on advancing more applied research in biohealth innovations to improve health delivery and address health disparities, which can be achieved by pursuing a biohealth development pathway.

A high level summary of each Consortium member's assets and interests point to these converging interests in applied research and health disparities:

EVMS:

- Existing applied research interests in reproductive, fetal and maternal health, pediatrics, community health, diabetes, simulation and immersive learning and cancer molecular diagnostics (proteomics)
- Institutional commitment to growing its capacities in health care delivery science
- Significant population health and health disparities efforts involving pediatrics and substance abuse

Sentara:

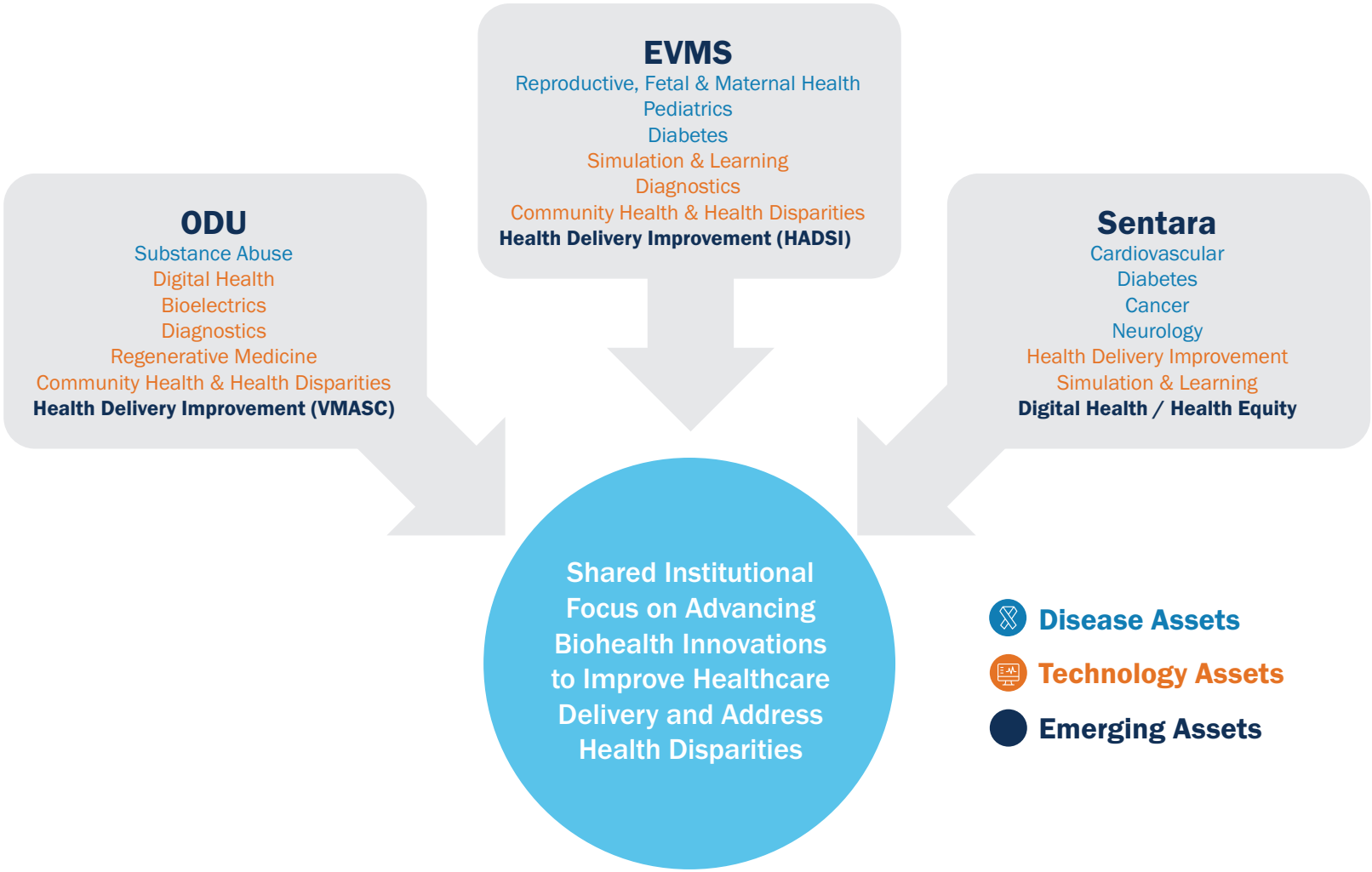
- Continual focus on process improvements and execution for clinical excellence
- Nationally ranked in recent years for clinical care excellence in cardiology, diabetes & endocrinology and nephrology as well as high performing in cancer, gastroenterology, geriatrics, urology, & orthopedics.
- Active in healthcare innovations involving digital health
- Active as a site for clinical trials though typically not a sponsor or collaborator
- Institutional commitment to health equity

ODU:

- Existing applied research interests in digital health (telemedicine), bioelectrics, substance abuse, community health and stem cell biology applications
- Leadership commitment to deepen its efforts to leverage strength in VMSC for for health systems engineering applying expertise in computational modeling and simulation, data analytics and cyber-physical systems
- Substance abuse is active area of health disparities research

Figure A-7 presents where each of the founding Consortium members plays a major or emerging role today across the disease and technology assets. What emerges is significant alignment focused on digital health, simulation, community health & health disparities and healthcare delivery for all three founding Consortium members, complemented by capabilities in specific disease and technology assets by individual members. The common focus based on Work Group discussions among the Consortium members is advancing innovations through improved healthcare delivery and addressing health disparities that leads to commercialization of new products and formation of new ventures.

Figure A-7. Summary of Consortium Member's Major and Emerging Roles in Disease and Technology Assets for Hampton Roads and Shared Interests



Cancer Disease Asset

Documented Activities in Region

Peer-Reviewed Publications: Active, but not specialized and low in citations

- 108 publications since 2016, with a low level of specialization of 0.36
- Low average citations of 2.77 per publication

Federal Research Grant Activities: Seven NIH funding research grants + others

- 3 NIH grants at ODU involving use of bioelectrics – a R21 grant for tumor ablation in breast cancer, and 2 R01 grants for delivery of therapeutic molecules and gene therapy delivery
- NIH R01 at ODU on development of neuro-radiology tool for quantitative image modeling of brain tumors
- NIH U01 at EVMS on protein biomarkers for prostate cancer
- NIH R21 at EVMS on structural biology of myosin motors involved in cancer metastasis
- NIH R15 grant on single cell imaging of ovarian cancer stem cells (oCSCs) to identify cancer stem cells for early diagnosis and to study their differentiation mechanisms
- NSF grant for a non-invasive sensor device to detect biomarkers for lung cancer.
- DoD/Army grants to EVMS on: 1) early detection of tumor relapse in triple-negative breast cancer; and 2) Glycosylation and aggressive prostate cancer progression

Clinical Trials: Active across clinical trial phases, but not leaders

- Limited leadership role in clinical trials – a sponsor/collaborator on only 2 interventional trials and 3 observational
- Active as a site for individual clinical trials with 305 – a good distribution across phases with 106 at phases 1 and 2 and 146 at phases 3 and 4

Clinical Excellence:

- High performing in overall cancer care though not nationally ranked
- High performing in lung cancer surgery

Other Non-Participant Activities in Region:

- Hampton University:
  - Established a Proton Therapy Institute in 2010, but no research efforts identified
  - Two NIH funded cancer grants – one on therapeutic research and the other on analysis of genetic variants in African Americans with breast cancer

Structured Interviews: Qualitative Insights

- Sentara is the driver of the region's cancer disease asset and a new cancer center is being completed to offer centralized outpatient services and help meet the expected growth of cancer patients in the region
- As in other clinical fields, the strength of Sentara is based on its high volume of patient populations and culture of continual process improvements to advance clinical excellence and interest of physicians
- Active in collaborations with outside organizations, but typically done on a opportunity-by-opportunity basis
  - George Mason University on biomarker development
  - LifeNet on chemo-sensitivity assay
- Strong interest by EVMS in growing cancer biomarker discovery, but needs deeper base of biorepositories. Currently making use of Urology of Virginia biorepository stored at EVMS. Few other biorepositories found in the region.
- Key opportunities for advancement suggested:
  - Address health care disparities in the region, including access to screening and other prevention services
  - Working with VCU Cancer Center and EVMS on a P20 grant on health disparities related to lung cancer
  - Complement growing biomarker discovery with availability of biorepositories along with added capacity in genetic epidemiology to integrate with population health needs and health disparities
- Interest in focusing on linkage of obesity and cancer

Cardiovascular Disease Asset

Documented Activities in Region

Peer-Reviewed Publications:

- 83 publications since 2016
- 42% less specialized than the nation
- Strong average citations at 6.05 per publication

Federal Research Grant Activities: A small number of research grants with no focus in a specific basic research or technology area:

- NIH R01 grant to EVMS on immune system involvement in atherosclerosis through B cell activation
- NIH R01 grant to ODU using bioelectric nanosecond pulsed electric field to achieve higher efficiency of defibrillation with improved clinical outcomes
- NIH R21 grant to ODU on use of molecular imaging tools to rationally direct the regeneration of cardiac cells from stem cells
- NSF grant to ODU to advance non-invasive monitoring of the cardiovascular system using a microfluidic-based tactile sensor and associated model-based analysis

Clinical Trials: Active, but not leaders

- Limited leadership role in clinical trials – a sponsor/collaborator on only 2 observational trials
- Active with 109 individual clinical trials though none at early phases. Mostly interventional, but a body of observational trials, including those involving patient registry

Clinical Excellence:

- 32nd in cardiology and heart surgery: Sentara Norfolk General
- High-performing in numerous procedures and conditions:
  - Abdominal aortic aneurysm repair
  - Aortic valve surgery
  - Heart bypass surgery
  - Heart failure

Structured Interviews: Qualitative Insights

- Sentara is the driver of the cardiovascular disease asset
- Strength of Sentara is based on its culture of continual process improvements to advance clinical excellence and interest of physicians
- Already very wide-ranging in its clinical strengths
- Active through Cardiac Research Institute in late stage, industry sponsored clinical trials in which Sentara is able to enroll high numbers of patients
- Key opportunities for advancement suggested:
  - Developing more integrated multi-disease program activities, such as cardiovascular complications from diabetes
  - Establish Sentara as a national leader in cardiovascular health outcomes research including pragmatic and comparative effectiveness trials
  - Build upon strong physician interest in “innovation” to convert process improvements into new clinical tools
  - Deepen the focus on clinical research by CRI to establish capabilities to be thought-leaders for early phase clinical trials

Diabetes

Documented Activities in Region

Peer-Reviewed Publications: Modest level with high average citations

- 70 publications in Endocrinology and Metabolism since 2016
- Strong average citations at 8.46 per publication

Clinical Trials: Active, but not leaders

- 2 active clinical trials in which EVMS was a sponsor or collaborator
- Site for 32 clinical trials, mostly later phase trials

Federal Research Grant Activities: Limited research grants with a mix of technology focuses:

- NIH R01 grant to EVMS on basic research to address loss of insulin producing beta cells in pre-diabetic and type 2 diabetes
- NIH R01 grant to ODU on community health and health disparities in obesity for young adult lesbian women and black women
- NSF grant using bioelectrics for development of a mobile smart glucose monitoring system
- DoD/Army basic research grant on extracellular vesicles MiRNAs as mediators of sleep fragmentation effects on diabetes and liver disease progression

Clinical Excellence: Nationally ranked by US News & World Report:

- 31st in diabetes and endocrinology: Sentara Norfolk General
- Leverages clinical strength of EVMS Diabetes Center

Structured Interviews: Qualitative Insights

- Ongoing clinical research focus of EVMS Diabetes Center is on diabetic complications involving neuropathy.
  - Infrastructure in place for measuring diabetic neuropathy
  - Key area of recruitment of new faculty
  - Collaborations beginning with Sentara in overlap of diabetes and cardiovascular disease
- Despite large public health need in region, diabetes has not been a significant focus for health disparities or population health studies
- Opportunity to leverage biological samples found at the EVMS Diabetes Center for a higher functioning biorepository

Neurology

Documented Activities in Region

Peer-Reviewed Publications: Substantial number, but not specialized and average citation levels

- 137 publications in Neurosciences since 2016, but not specialized & average in citations (3.54)
- 84 publications in Clinical Neurology since 2016, but not specialized & 4 citations per pub

Clinical Trials: Active as clinical site for early phase trials, but not a leader

- 2 active clinical trials in which EVMS was a sponsor or collaborator
- Site for 86 clinical trials, with a strong emphasis on Phase 2 efficacy as well as a substantial number observational trials

Federal Research Grant Activities: Limited research grants with a mix of technology focuses:

- NIH R01 grant to EVMS on neurobiological mechanisms of fearful/stressful memories and impact on sleep
- NIH RO1 to ODU on quantitative image modeling for brain tumor analysis
- Ongoing NASA grants to EVMS for basic research on impact of radiation on brain function/ neurocognition involving use of neuroimaging
- NSF grant to ODU on tools for real-time imaging of neural synapses

Clinical Excellence: Nationally ranked by US News & World Report

- Not ranked in Neurology & Neurosurgery

Structured Interviews: Qualitative Insights

- Many areas of neurology and neurosurgery where Sentara has strong clinical programs, but not research focused. Including:
  - Stroke program with expertise in telestroke
  - Movement disorders with connection to neurosurgery for implants
  - Spinal surgery
- Initial translational research project underway to advance new drugs for acute stroke … also interest in wellness and diet interventions
- Broader opportunities to advance use of digital health and neurology beyond telestroke … interest in use of wearables for both stroke and movement disorder
- EVMS has established an inter-disciplinary neuro-regulation group, examining how brain function links to other organ systems, including immune/inflammatory diseases
  - Brings together many of the NIH funded PIs at EVMS across sleep/ behavior and neurofunction with basic immunology and molecular biology researchers
  - Examine questions such as how sleep effects immune response to vascular diseases, neuro-regulation of sleep and advancement of atherosclerosis

Pediatric Disease Asset

Documented Activities in Region

Peer-Reviewed Publications: Active

- 84 publications since 2016
- Average level of specialization and citation

Clinical Trials: Active, but not leaders

- 16 pediatric clinical trials with sponsor or collaborator in the region
- 219 pediatric clinical trials with a site in the region – 74 are early phase trials

Federal Research Grant Activities: A small number of research grants

- NIH R21 grant to EVMS on peptide inhibitors of acute hemolysis from transfusions
- NIH U01 grant to ODU discover and validate novel small molecule compounds to treat infections in the middle ear
- 3 NIH grants to ODU to study community health and health disparities related to pediatrics, including childhood obesity and substance abuse

Industry Connections:

- ReAlta Life Sciences, a spin-off from CHKD and EVMS, is advancing novel peptide to address immune responses to blood transfusions

EVMS Division of Community Health in Pediatrics Department focused on demonstration projects and program evaluations:

- Since 2010, the Community Health division has been awarded more than $10 million in funding from outside sources, with 88 grants and contracts awarded for work in Hampton Roads communities.
- Areas of emphasis include: Substance abuse; Tobacco and air quality; Vaping and youth; Motor vehicle safety; Obesity; Maternal, infant and child health

Structured Interviews: Qualitative Insights

- Key asset of pediatrics in the Hampton Roads region is that health care delivery to pediatric population is highly consolidated across three physician practice groups either part of or associated with CHKD, who also serve as faculty for EVMS
- A pediatric clinically integrated network is being established with UVA to focus on improved outcomes and population health, including Medicaid population.
- New CHKD Pediatric Mental Health initiative including a 60-bed psychiatric facility and recruitment of up to 8-10 new physician-researchers that opens up opportunities for additional clinical research, and health outcomes/ population health studies.

Reproductive, Fetal and Maternal Health

Documented Activities in Region

Peer-Reviewed Publications: Leading Area

- 157 publications in Ob/Gyn since 2016
- Highly specialized, though citations lagging

Federal Research Grant Activities: NIH funding and long-standing USAID support

- 4 NIH grants to EVMS, including 1) R01 grant for developing novel ultrasound imaging tools for the noninvasive evaluation of the placenta to predict pre-term pregnancy complications; 2) R61 grant to develop a next-generation, long-acting HIV and contraception device using a anti-viral hydrogel; 3) N01 grant for a contraceptive clinical trial network; 4) clinical study of estrogen substitute for contraception to reduce the risk of venous thromboembolism (VTE), particularly for obese women.
- USAID grants to CONRAD to advance new methods of contraception and HIV prevention.

Clinical Trials: Active and Leader

- Sponsor and/or collaborator in 14 clinical trials involving Reproductive, Fetal and Maternal Health in recent years
- Site for 98 active clinical trials with just over 50% late phase trials.

Clinical Excellence

- Not ranked among top 100 in https://www.beckershospitalreview.com/lists/100-hospitals-with-great-womens-health-programs.html

CONRAD: Product Development Group with Ongoing Industry Connections:

- 50+ interdisciplinary team focused on developing new delivery devices, diagnostics and therapeutics related to new, safe and effective contraceptives and disease prevention for women's health
- Capabilities include: Product design led by bioengineers for vaginal rings and other delivery mechanisms; Pre-clinical studies – PK/PD and device proof-of-concept; Clinical Research Center for administering phases I-III trials; Regulatory; Quality Control
- Established industry relationships: GSK, Gilead, Pfizer, Merck, etc.

Structured Interviews: Qualitative Insights

Expert Ob/Gyn panel from Northwestern, Columbia and University of Texas noted strengths, including:

- National leadership in fetal diagnosis and ultrasound
- CONRAD provides a unique product development and clinical research resource
- Jones Institute brings strong clinical expertise with infertility treatments and cutting-edge embryo and implantation research

Vivarium and Baboon colony is a unique asset involved in longstanding research program focused on demonstrating the important role of estrogen in controlling placental-fetal communication. Key collaboration with University of Maryland, Baltimore. Recent pilot studies underway in blood flow to the uterus, how estrogen varies with health of women and the process of fetal programming leading to disease risks later in life.

Fertility research seeking a P-50 specialized center grant on new types of therapeutic interventions to address age-related infertility by understanding how to increase follicular development and serum estrogen levels to that found in younger women. Also examining development of new options for heavy menstrual bleeding other than pursuing hysterectomies.

Discussion on opportunities builds upon expert panel recommendation to create a Women's Health Research Institute

- Build upon NIH placenta research to create a unique resource for population health studies with integrated patient database and biorepository
- Broaden CONRAD to address wider range of women's health issues informed by unmet clinical needs, involving hepatitis, STI prevention, pre-term pregnancy, menopause
- Advance infrastructure to conduct pragmatic and comparative effectiveness trials
- Establish a clinical research network of in-vitro fertility clinics in Virginia
- Advance a women's health translational component, including focus on infectious disease, diabetes, cardiovascular health, neuroscience and inflammation

Substance Abuse

Documented Activities in Region

Peer-Reviewed Publications: Active

- 59 publications in Substance Abuse since 2016
- 63% more specialized than U.S., but low average level of citations of 1.95

Clinical Trials: Limited, but often sponsors and collaborators

- ODU's active research programs in substance abuse has led to it being a sponsor or collaborator on clinical trials ... among active and recently completed clinical trials, approximately 6.
- EVMS is more demonstration and program evaluation oriented, so fewer clinical research efforts

Federal Research Grant Activities: Strong connections of substance abuse with community health

- 4 NIH grants to ODU on community health related to substance abuse including college student drinking interventions, technology-based alcohol interventions, health disparities in alcohol use for young, minority women and causes and health consequences of synthetic drug abuse.
- NIH grant to EVMS on disparities in marijuana use among minority adolescents
- Grants at EVMS on community health related to smoking disparities and mental health, including HUD grant on assessing the impact of smoke-free public housing on smoking behavior, environmental tobacco smoke, third-hand smoke, other tobacco use and smoking-related disparities and a NIDA site investigator funding on smoking, suicide and mental health with Washington University

Structured Interviews: Qualitative Insights

- Substance abuse research in region is highly focused on health disparities and interventions.
- ODU is making use of digital technologies in addressing issues such as binge drinking.
- Opportunity to better mine patient electronic health records between ODU substance abuse researchers and Sentara. Also need to integrate substance abuse treatment center records.

Bioelectrics Technology Asset

Documented Activities in Region

Peer-Reviewed Publications: A unique field, with concentrated focus in region

- 24 publications since 2016 related to bioelectrics and electric pulse fields for therapeutic applications since 2016 – most research focused on electro-permeability of cells

Federal Research Grant Activities: Substantial area of research focus with multiple applications:

- Cancer: 3 NIH grants at ODU involving use of bioelectrics – a R21 grant for tumor ablation in breast cancer, and 2 R01 grants for delivery of therapeutic molecules and gene therapy delivery
- Cardiovascular:
  - NIH R01 grant at ODU using bioelectric nanosecond pulsed electric field to achieve higher efficiency of defibrillation with improved clinical outcomes
  - NSF grant on sensor for cardiovascular disease
- Diabetes: NSF grant on glucose monitoring system
- Gene delivery via Skin: 2 NIH R01 grants

Industry Collaborations: Long-standing industry partnership

- In the area of bioelectrics, ODU has a long-standing relationship with Pulse Technologies that has licensed IP and has right to first refusal to all IP involving use of nano-second pulse applications. In return, Pulse Technologies provides ongoing funding to ODU for research.
- Other advances being made that have potential for commercialization, including:
  - Biosensors
  - New treatment for sepsis in collaboration with EVMS
  - Wound healing using Platelet Rich Plasma
  - Defibrillators

Structured Interviews: Qualitative Insights

- Bioelectrics is a unique field that explores the application of electromagnetic fields to biological systems
  - Biological response of living cells to pulse electric fields include activation of ion channels, modulation of protein structure and identification and characterization of protein machinery
  - Applications are far-ranging: cancer tumor eradication; micro-fluidic devices; gene delivery; wound healing
- Key opportunities for advancement suggested:
  - Broaden research program into bioelectronics – would open up development of wearables using biomaterials, probes for brain imaging, etc.
  - Create more collaborations with clinicians to identify key opportunities for use of bioelectrics and broader bioelectronic applications

Community Health & Health Disparities Technology Asset

Documented Activities in Region

Peer Reviewed Publications: Active, but low in citations

- 109 publications in Public Health since 2016, with a low average citations per publication of 2.14 and 33% less concentrated than nation
- 27 publications in Health Policy & Services, with a low average citation per publication of 1.48 and 42% less concentrated than nation

Federal Research Grant Activities: Strong connection of community health to substance abuse, among other conditions.

- NIH grant through American College of Surgeons to determine surgical disparities-sensitive measures to develop targeted interventions aimed at eradicating disparities and improving outcomes
- 4 NIH grants to ODU on community health related to substance abuse including college student drinking interventions, technology-based alcohol interventions, health disparities in alcohol use for young, minority women and causes and health consequences of synthetic drug abuse.
- NIH grant to EVMS on disparities in marijuana use among minority adolescents
- Grants at EVMS on community health related to smoking disparities and mental health, including HUD grant on assessing the impact of smoke-free public housing on smoking behavior, environmental tobacco smoke, third-hand smoke, other tobacco use and smoking-related disparities and a NIDA site investigator funding on smoking, suicide and mental health with Washington University
- 2 NIH RO1s at ODU on reducing obesity disparities in racially diverse lesbian and heterosexual women and among WIC eligible children.
- HHS Health Services grant to ODU for a social-ecological suicide prevention program
- NIH R01 at ODU on spatial eco-epidemiology of tick-borne diseases

8 Health Disparity Pilot Grants awarded by Health Analytics and Delivery Sciences Institute:

- Including for: Diabetes and Cardiovascular Revascularization; Thyroid Cancer; Use of Mobile Health Clinic in Underserved Communities; Cutaneous Melanoma; Colorectal Cancer; Lung Cancer; Psoriasis and Eczema Research; Rehab and Opioid Use

Structured Interviews: Qualitative Insights

- ODU emphasis is being placed on connecting with local communities on health prevention, especially around substance abuse and obesity. Bringing an interdisciplinary approach.
- EVMS strength in implementation science with lots of community health work focusing on demonstration projects and program evaluations utilizing strengths in implementation science involving evidence-based interventions, but more limited in its research activities.
    - Web site reports: Since 2010, the Community Health division has helped EVMS win more than $10 million in funding from outside sources, with 88 grants and contracts awarded for work in Hampton Roads communities.
    - Areas of emphasis include: Substance abuse; Tobacco and air quality; Vaping and youth; Motor vehicle safety; Obesity; Maternal, infant and child health
    - Examples include: a large-scale behavior-change program to encourage the use of booster seats in vehicles; Healthy Kids initiative to work with early care and education centers on diet and physical activity; Consortium for Infant and Child Health to promote breastfeeding.
- Sentara launching a health equity initiative with an intentional and sequential focus from “data to hypotheses to interventions”
    - Just at the starting point, with engagement of a consulting organization to develop the initial data assessment of health disparities in comparison to other regions based on: race, ethnicity, language, sexual orientation and socio-economics.
- Key opportunities for advancement suggested:
    - Focus around population health management that links a deeper population health assessment capacity with current strengths working with local communities (i.e. public housing) and in implementation science capabilities to advance innovations through evidence-based interventions

Diagnostic Tools Technology Asset

Documented Activities in Region

Peer-Reviewed Publications: Broad base of activities taking place related to diagnostic tools

- 85 publications in Genetics since 2016 with average levels of citations per pub and specialization
- 73 publications in Radiology, Nuclear Medicine and Medical Imaging since 2016 with 4.27 average citations per publication, though not specialized
- 59 publications in Biotechnology & Applied Microbiology since 2016, with 63% higher specialization, though low level of average citations
- Examination of genetics/biotech publications found ~30% deal with specific genetic biomarkers based on titles and/or key terms

JLab Radiation Detector and Imaging Group

- Developing compact, radioisotope imaging systems as well as hand-held imaging and non-imaging intraoperative probes for 1) dedicated organ imaging for cancer, including breast, brain and heart imaging and 2) high resolution, high sensitivity gamma imaging of small animals. Collaborating with Dilon Diagnostics

Broader Base of Patent Innovation in Hampton Roads Related to Optics, Imaging, Sensing and Spectroscopy

- More than 20 patent classifications involving optics, imaging, sensing and spectroscopy generated over 750 patents from 2016 to mid-year 2019 – showing depth of region in core technologies for advancing diagnostic tools

Federal Research Grant Activities: Active Number of Grants Across Diverse Range of Diagnostic Tools

- NIH U01 at EVMS on protein biomarkers for prostate cancer
- NIH R01 at EVMS for developing novel ultrasound imaging tools for the noninvasive evaluation of the placenta to predict pre-term pregnancy complications
- NIH RO1 to ODU on quantitative image modeling for brain tumor analysis
- NIH R15 grant to ODU on single cell imaging of ovarian cancer stem cells (oCSCs) to identify cancer stem cells for early diagnosis and to study their differentiation mechanisms
- NSF grant at ODU for a non-invasive sensor device to detect RNA biomarkers for lung cancer
- NSF grant to ODU to advance non-invasive monitoring of the cardiovascular system using a microfluidic-based tactile sensor and associated model-based analysis
- NSF grant to ODU on tools for real-time imaging of neural synapses

Structured Interviews: Qualitative Insights

- Mix of opportunities to advance diagnostic technologies involving identification of biomarkers using proteomics/mass spec, single cell imaging, biosensors, ultrasound imaging and neuroimaging
- Typically research being done through PI own lab, though EVMS has a shared use lab on biomarker discovery development and validation lab in place at the Leroy T. Canoles Jr. Cancer Research Center
  - Has been identifying novel biomarkers using proteomics/mass spectrometry for detecting advanced prostate cancer – but partners outside region for computational and genomics support
  - Part of the National Cancer Institute's Early Detection Research Network
  - Advancement of biomarker discovery requires significant investment in biorepository capabilities
    - Two established biorepositories – Urology of Virginia biorepository and Placenta biorepository
    - Limited capacities in biorepository for analysis – histology core, but no nextgen sequencing
    - No broad consent process in place
    - No linkage of clinical data with biospecimens

Digital Health

Documented Activities in Region

Peer-Reviewed Publications: Computer and Computational Sciences is a Leading Area
Five of the top 10 publication fields in Hampton Roads are in computer and computational sciences, including:

- 202 publications in Computer Sciences/Information Systems since 2016, 119% more specialized than the nation
- 162 publications in Mathematics, 140% more specialized than the nation
- 147 publications in Computer Sciences/Interdisciplinary Applications, 122% more specialized than the nation
- 135 publications in Applied Math, 130% more specialized than the nation
- 124 publications in Computer Science/Software Engineering, 179% more specialized than the nation

Plus: 88 publications in Hardware & Architecture and 80 publications in AI

Federal Research Grant Activities:

- NIH R01 grant to ODU in quantitative image modeling for brain tumor analysis and tracking
- Several NSF grants to ODU in computer and computational sciences that might have biomedical applications including: 1) Algorithms to solve non-equilibrium microflows found in sensor, microfluidics and microelectromechanical systems; 2) Modeling of fluid-particle mixtures; 3) Large, multi-scale data modeling; 4) Protocols and algorithms for wireless device-to-device communications in 5G cellular environment

Industry Connections:

- ODU-Sentara collaboration on use of block chain technology to detect and alert the presence of rogue medical Internet-of-Things devices, with new start-up company (Bloxure)
- Sentara is involved in several consortiums involved in Digital Health, including a blockchain consortium with IBM, a Cloud Security Healthcare Platform with EPIC and Microsoft and AVIA Innovator Network

Structured Interviews: Qualitative Insights

- Simulation is an active area of digital health in the region. Ongoing efforts in simulation at both EVMS and Sentara can offer a platform where key healthcare delivery issues can be addressed in a more integrated medical team approach including transitions in care and addressing end-of-live issues.
- Telehealth another active area of digital health activities in the region. ODU's School of Nursing has received approximately $7 million over the last five years from DHHS HRSA for telehealth and recently launched a new Center for Telehealth Innovation, Education and Research – ODU's focus is on the process of using telehealth, such as telehealth etiquette, human factors and skills development
- Sentara is also actively using telehealth, including for its telestroke program and its home care services efforts, where it is currently piloting the use of tablets into the home with monitoring capabilities developed by Health Recovery Solutions.
- Strong interest from ODU's Virginia Modeling, Analysis and Simulation Center (VMASC) to establish a health systems engineering initiative to bring forward its software, data analysis and cyber-physical system/IoT capabilities to address unmet clinical needs.
- Big picture would be to put Hampton Roads as a leading developer of the emerging new paradigm of digital health delivery that advances meaningful personalized relationships with patients using digital tools
    - Build out software, data analytics, IoT, human factors, and processes and services to deliver an evidence-based, high-touch approach to advancing patient-center healthcare
    - Requires a business model of how to bring digital healthcare innovations to market
    - Offers great opportunities to customize digital health delivery to the needs of specific underserved populations to address health care disparities

Health Delivery Improvements

Documented Activities in Region

Peer-Reviewed Publications: Active across health services and nursing, but low quality of publications

- 61 publications in Health Care Sciences & Services since 2016, with a low level of specialization of 0.62 and low average citations of 2.46 per publication
- 52 publications in Nursing since 2016, close to national average share, but low average citations of 1.17

Federal Research Grant Activities:

- NIH grant through American College of Surgeons to determine surgical disparities-sensitive measures to develop targeted interventions aimed at eradicating disparities and improving outcomes

Clinical Improvements in 2018: Sentara Focus on Value through Systemwide Clinical Appropriateness

- Reduce Readmissions:
  - 620 fewer hospital readmissions
  - 127 fewer post-acute readmissions
  - 87 fewer medical group readmissions
- 30-day Inpatient Mortality – 109 fewer
- Emergency Department Flow – 32,583 more patients treated and released with goal timeframe
- Hospital Flow – 10,732 more patients were treated and admitted within the goal timeframe
- Appointment Availability – 75,000 more patients were satisfied with their appointment availability

Pilot Grants awarded by Health Analytics and Delivery Sciences Institute:

- 11 grants to date focused on health delivery sciences including: Use of Advanced Care Plans; Surgical Management of Epistaxis; Hospice Care; Cardiovascular disease in diabetic population; HDL Levels and Sepsis; Emergency Department usage after disaster; Brain Injury; Opioid prescribition; Acute kidney injury; Glucose monitoring for Coronary Artery Bypass Graft; Antipsychotic medication and CV events in long-term nursing home residents.

Structured Interviews: Qualitative Insights

- Sentara brings a strong culture and focus on execution around improvements and evidence-based approaches in health care delivery that reaches broadly across service lines and business units
  - Blue-printing process to identify best practices found at Sentara hospitals and key factors that drive the outcomes
  - Systemwide clinical appropriateness process then seeks to standardize care to reduce variability with multi-disciplinary teams of physicians, nurses, process engineers
  - Makes use of electronic health records to identify opportunities, make the business case for improvements and track success
- Need for continued advancement in healthcare delivery infrastructure to make more effective use of health data analytics, develop process improvements into clinical health tools and lead clinical trials that define leadership in healthcare delivery
  - Significant investment required to convert electronic health records into data models required for data sciences insights
  - Capacity needed for advancing algorithms and implementation of AI/ML to mine data also need human factors/behavioral science capacity to determine whether an identified innovation opportunity can be adapted into clinical practice
  - Lacking capacity to “productize” process improvements into clinical software tools for health services products
  - Raise national recognition with investment in capacity to undertake pragmatic trials to identify evidence-based interventions
    - Pragmatic trials are run in real-world settings, test interventions compared with usual care (rather than placebo) and are conducted in a way that seeks to enhance the generalizability of the results that they produce.
  - Opportunity to leverage the systems engineering capabilities of ODU’s Virginia Modeling and Simulation Center for modeling of data and complex health care system improvements and developing into tools and new products
- Link development of health disparity metrics with where improvements in healthcare interventions can be advanced

Regenerative Medicine

Documented Activities in Region

Peer-Reviewed Publications: Limited

- 14 publications related to stem cell applications in broader field of cell biology
- 9 publications in cell & tissue engineering

Federal Research Grant Activities: Limited

- NIH R21 grant to ODU on regeneration of cardiac cells from stem cells
- NIH R21 grant to ODU to enable a better mechanistic understanding of key events in cell development with implications for wound healing in adult tissues as well as what disrupts tissue organization in diseases like cancer
- NIH R21 grant to ODU on a three dimensional bioprinting approach to mapping critical determinants of stem cell asymmetric divisions
- NIH R15 grant on single cell imaging of ovarian cancer stem cells (oCSCs) in highly heterogeneous tumor cell populations to study their differentiation mechanisms

Industry Connections:

- LifeNet – A non-profit company involved in procurement and distribution facility for human organs, tissue grafts and bio-implants. Has established an Institute of Regenerative Medicine with a focus on new medical applications for allograft and tissue engineering. One VBHRC grant was for enhancement of healing in diabetic wounds using a decellulrized dermal matrix and a second grant was for tissue preparations for therapeutic use in cardiovascular applications
- Embody, an ODU spin-off venture, that is focusing on the development and commercialization of implantable medical devices to address the unmet demands in soft tissue restoration and regeneration.

Structured Interviews: Qualitative Insights

At ODU, there is a group of translational focused basic researchers advancing stem cell bioengineering to advance applications primarily in regenerative medicine.

Bioelectrics capabilities at ODU can also be applied to regenerative medicine for wound repair using platelet rich plasma and delivery of growth factors

Need opportunity for more engagement with clinicians to identify unmet clinical needs for applications – consider use of seed grants for pilot studies that supports researcher as well as release time for physician.

A concern is ability of ODU to compete for top quality graduate students with limited stipends.

Simulation, Human Learning and Gaming

Documented Activities in Region

Sentara's Existing Medical Simulation Capabilities:
Sentara Clinical Education and Simulation supports New Hire Immersive Simulation experiences and systemwide clinical priorities, EPIC integration and implementation – in 2018, 189 simulation center classes taught with 3,634 participants.

- Very operational focused to focus on improving healthcare delivery by ensuring standardization of evidence-based practice and reducing variations in care.
- Enables nursing staff to learn and practice new protocols and standards of care within a simulation of the overall hospital setting that focuses on specific situations and skill development.

ODU Offers a Broader Technology and Education base for Advancing Healthcare Simulation Capabilities:

- In applied technology development and innovation, ODU VMASC through its research faculty offer capabilities in virtual and augmented reality, human-computer interaction, agent-based modeling and simulation of group dynamics, cloud-based simulation engines and user interfaces, interoperability of simulation models and use of simulation for advancing innovative solutions.
- In education, ODU is training the next generation of both modeling and simulation experts as well as gaming designers and programmers.

EVMS's Existing Medical Simulation Capabilities:
Sentara Center for Simulation and Immersive Learning at EVMS uses simulation tools and techniques to bring a hands-on approach to teaching common medical procedures and how to handle difficult patient interactions. Serves as a resource for students and faculty to conduct research in the use of educational technologies, simulation devices and novel curricula.

- Serves 85 external customers, including other medical schools.
- SCSIL offers a full complement of simulation tools and techniques that uses technology to teach common medical procedures in a safe environment for medical students.
- State-of-the-art facilities include: 16 clinical exam rooms; Six group skills rooms to stage emergency department, operating room or ward training with the use of mannequins; Immersive virtual environment; Observation suite; Classroom with audiovisual recording and streaming technology; Production studio; Task trainer/procedural device room; Audiovisual recording and review capability (CAE LearningSpace)

Industry Connections:

- EdLogics offers a gamified platform rooted in learning theory and behavioral science to employers, health plans, and other organizations to improve health literacy and drive positive behaviors by educating people in fun and engaging ways. Lead player in organizing "Healthier Hampton Roads Initiative" focused on health care disparities, health literacy and improvement of public health to impact the region's economic development.

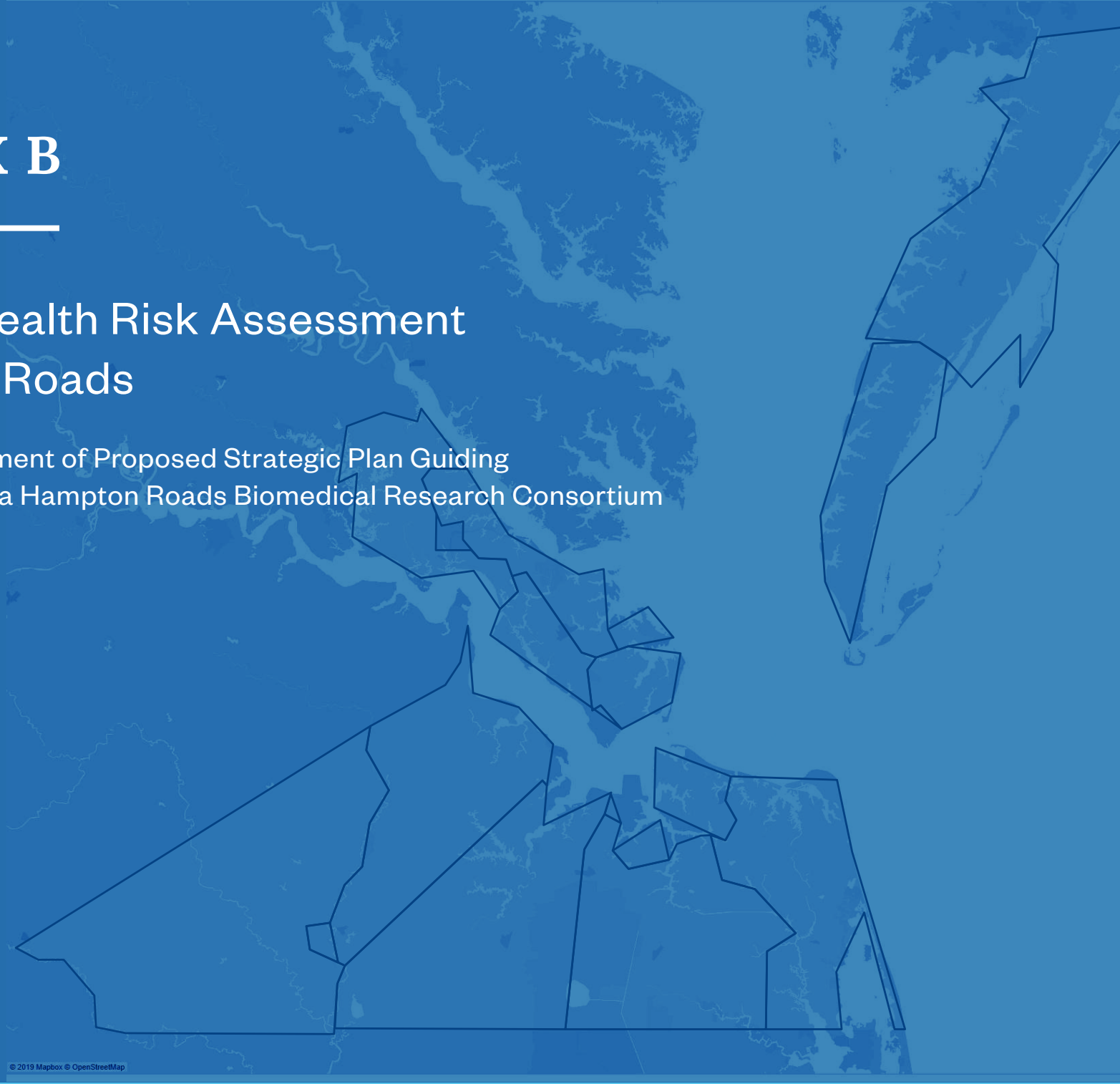
Structured Interviews: Qualitative Insights

- Ongoing efforts in simulation at both EVMS and Sentara can offer a platform where key healthcare delivery issues can be addressed in a more integrated medical team approach including transitions in care and addressing end-of-live issues.
- Important to broaden use of simulation as a tool that integrates the different characteristics of targeted sub-population segments experiencing health disparities into simulating healthcare treatment scenarios to allow for a "virtual/ augmented reality" laboratory for advancing improved healthcare delivery approaches.
- Use human learning approaches for targeted sub-groups to improve health literacy and healthy behaviors
- Have Sentara and EVMS engage with ODU's Virginia Modeling, Analysis and Simulation Center to advance applied research and innovation in the use of serious medical games and other simulation tools

APPENDIX B

Population Health Risk Assessment for Hampton Roads

Prepared in Development of Proposed Strategic Plan Guiding the Establishment of a Hampton Roads Biomedical Research Consortium



This Appendix to the proposed strategic plan for the Hampton Roads Biomedical Research Consortium (HRBRC) provides a situational assessment for the Hampton Roads of its population health risks as reflected in the overall population health conditions, needs and disparities found in the region. This is a key planning component called for in the Budget Bill (HB1700),[5] which recognizes that regional biomedical development offers a close relationship between research and clinical care that can be informed by as well as improve population health conditions, needs and disparities.

This analysis examines the following characteristics pertaining to the health risks and needs facing the Hampton Roads region's population by:

- Summarizing publicly available reports on community health in the region
- Describing the components of the Hampton Roads region and explores overall demographic, economic, and quality of life conditions in the cities and counties that it comprises.
- Looking at the disease areas where the region has the largest needs. This includes an in-depth look at cancer, cardiovascular disease, diabetes, stroke.
- Assessing the state of the health of the region's women and children, with a particular focus on maternal health and pregnancy, and infant and early childhood health.
- Emphasizing the negative roles of substance abuse, including alcohol and tobacco use, as well as deaths and hospitalizations due to opioids, heroin, and fentanyl.
- Exploring access to care and the barriers that prevent some individuals who from receiving necessary care.
- Synthesizing health data by geography to identify specific cities facing elevated hazards, as well as other underlying factors that exacerbate these needs.

Through an assessment of the multiple measures that make up each of these categories and sub-categories, a clearer picture of population health in the region begins to form.

Summary Findings

The composition of the Hampton Roads region makes it relatively unique for a metropolitan area: no single city accounts for more than 27 percent of the total population, though the largest seven cities account for approximately 85 percent of the total. The population health needs of the Hampton Roads region are most stark in some of these largest cities. There are notable disparities in population health throughout the region, and cities with larger minority populations and higher poverty rates tended to have worse health outcomes.

The leading disease areas of research – as identified by research grants, publications, clinical trials and clinical excellence – are also areas of extensive population health needs for the region (Figure B-1). For example, Figure B-1 shows that the "priority health areas" for Sentara's hospitals in the region aligns with the leading disease areas of research identified in Appendix A.

5 *475.10, HB1700, "The plan shall…conduct a health risk assessment of the region's population."*

Figure B-1. Priority Health Problems Align with Identified Research Strengths

	Identified Disease Areas							Other Sentara Priority Areas	
	Cancer	Cardio-vascular	Diabetes	Neurology	Pediatric Health	Reproductive Health	Mental Health and Substance Abuse	Food + Nutrition + Obesity	Community Health + Outreach
Norfolk General									
CarePlex									
Williamsburg									
Leigh									
VB General									
Obici									
Princess Anne									

Priority Area is Closely Related

Priority Area is Closely Related

Source: 2019 Sentara Community Health Needs Assessments, analysis by TEConomy

A TEConomy analysis of data made available through the Greater Hampton Roads Community Indicators Dashboard finds additional evidence across these seven health need areas:[6]

Cancer: There are 454.7 cases of cancer diagnosed per 100,000 population in the median Hampton Roads county, a rate 9.0 percentage points higher than the median for all U.S. counties (445.7 cases). Nearly three-quarters of Hampton Roads' population lives in a city/county where the cancer incidence is in the bottom 50th percentile among all U.S. counties. High cancer rates among the region's Medicare population are especially pervasive: Nearly one-in-ten Medicare beneficiaries are treated for cancer in Hampton Roads (9.8), a rate that is noticeably higher than the median U.S. county (7.4 percent).

Cardiovascular: More than three-quarters of Hampton Roads' population (77.7 percent) lives in an area where the age-adjusted hospitalization rate for heart failure are in the bottom quartile of Virginia counties. The rate of heart-failure hospitalization in the median Hampton Roads city/county is 39.5 cases per 10,000 population aged 18 years and older, compared to 36.7 in the median Virginia county. Throughout Hampton Roads, there are notable racial disparities in the hospitalization rate due to heart failure: In most Hampton Roads counties, the hospitalization rate for whites was less than half that of Black residents.

6 *For the purposes of this study, "Hampton Roads" is defined by 14-counties in Virginia (in order of population): Virginia Beach; Norfolk; Chesapeake; Newport News; Hampton; Portsmouth; Suffolk; James City; York; Gloucester; Isle of Wight; Williamsburg; Poquoson; and, Mathews.*

In Norfolk, the hospitalization rate due to heart failure is roughly four-times as high for Blacks (113.1 cases per 10,000 population) as it is for whites (37.3 cases per 10,000 population).

Diabetes: In the median Hampton Roads county, 10.8 percent of adults ages 20 and older had diabetes, a rate that is nearly a full percentage point higher than median U.S. county (9.9 percent). The region's Medicare beneficiaries are particularly susceptible: 29.7 percent of the Medicare recipients in the median Hampton Roads county have diabetes, compared to 27.1 percent in the median U.S. county. Nearly two-thirds (65.0 percent) of the region's population lives in a county where Medicare diabetes rates are in the bottom half of U.S. counties.

Neurology: In the median Hampton Roads county, 3.9 percent of Medicare beneficiaries are treated for stroke, compared to 3.4 percent in the median U.S. county. Stroke rates among Medicare beneficiaries are elevated throughout the region, with 95 percent of the population living in a county where stroke rates were in the worst 50th percentile of U.S. counties.

Reproductive, Fetal and Maternal: Nearly one-in-10 of babies (9.5 percent) born in the median Hampton Roads county had a low birthweight, while 1.8 percent of babies born in the median Hampton Roads county had a very low birthweight. In both instances these shares are higher than the U.S. value. On average, the share of Black babies born with low birthweight is more than twice the rate for white babies throughout Hampton Roads.

Pediatrics: In the median Hampton Roads county, the age-adjusted hospitalization rate due to mental health per 10,000 population under 18 years is 31.6, compared to 26.4 in the median Virginia county. The vast majority of Hampton Roads' population lives in a county where hospitalization rates for pediatric mental health are in the worst quartile of Virginia Counties.

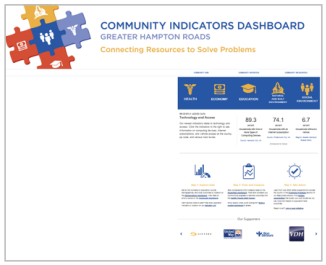
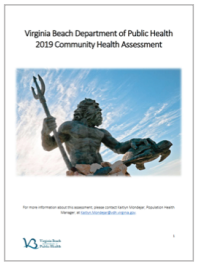
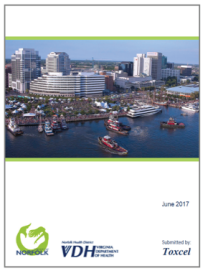
Substance Abuse: The heroin-related emergency department visit rate was 18.4 visits per 100,000 population in the median Hampton Roads county, compared to 8.1 visits per 100,000 population in the median Virginia county. More than 90 percent of the region's population lives in a county where the heroin-related emergency department visit rate exceeded the Virginia county median.

Health care delivery: Health insurance coverage rates for the region's population ages 18 to 64 are higher in the median Hampton Roads county than in the median U.S. county. However, more than two-thirds of the region's population (68.3 percent) lives in an area where coverage rates are below the U.S. median, which suggests that rates are lower in the region's largest cities. Although the share of adults reporting that they have visited a doctor for a routine checkup in the past year is generally higher in Hampton Roads' largest cities than in similar sized cities throughout the country, this rate is decreasing in three of the region's seven large cities.

Methodology

As a way to identify areas of concern in population health needs for the region, TEConomy reviewed the latest reporting of data and research in the Hampton Roads community. Four types of publicly available information were utilized for this assessment: Hospital-based Community Health Needs Assessments, City-based Community Health Assessments, City-based Community Health Improvement Plans, and the Greater Hampton Roads Connects Community Indicators Dashboard.

Figure B-2. Examples of Publicly Available Health Assessments Examined with Key Findings

Greater Hampton Roads Connects Community Indicators Dashboard	*Sentara Community Health Needs Assessments (2019 Update)*	*Virginia Beach Dept. of Public Health 2019 Community Health Assessment*	*Norfolk Community Health Improvement Plan (CHIP)*
			
Standardized data for 100+ indicators allows for look across the region and benchmark comparisons.	Supplements GHRConnects data with in-depth look at particular HR geographies.	Developed to inform a future health strategies for Virginia Beach.	Proposed as a plan for action for addressing community health in Norfolk.
Finding: Risks and disparities in cancer, cardiovascular, natal health, and substance abuse.	**Finding: Issues with cancer, diabetes, and cardiovascular health. Increasing challenges related to substance abuse.**	**Finding: Health problems stemming from mental health and substance abuse issues.**	**Finding: Importance of community, chronic disease prevention, sexual health.**

Source: Analysis by TEConomy

The Community Health Needs Assessments (CHNAs) and Improvement Plans (CHIPs) conducted by the public and nonprofit sectors in the Hampton Roads region are rooted in quantitative analysis, community engagement and collaborative participation. Based on TEConomy's analysis of these publicly available reports, several disease areas emerged as high need in the region: cancer, cardiovascular health, neurology and mental health, fetal and maternal health, behavioral health, and substance abuse.

The following sections will summarize key findings from the reports across these disease areas. Additionally, to dive deeper in these areas, TEConomy utilized data made available from the Greater Hampton Roads Connects Community Indicators Dashboard (GHRConnects) to paint a broader picture of population health in the region. This allows for up to date and standardized data across users, providing important context for these health needs and disparities.

GHRConnects is a partnership between the region's United Way, Sentara, Bon Secours, and the Virginia Department of Health, and played a valuable role in assembling data for this section of the report. According to its website, "The Greater Hampton Roads Community Indicators Dashboard measures factors that most significantly impact our region's quality of life." The dashboard seeks to track "meaningful, accurate, and standardized data over time to give a clearer picture of how our community is doing."

Last December, the major hospital systems in Hampton Roads agreed to use this common data set for their 2019 community health studies.

Similarly, using GHRConnects for this study allows for a greater congruency between the many assessments already underway in the region.

This examination of regional population health focuses on the prevalence of health needs: areas where the median Hampton Roads city/county fares worse than the national or Virginia median levels. There is further emphasis on the pervasiveness of health needs: whether a significant portion of the region's population lives in a city/county that is worse than these benchmarks.

Using GHRConnects data, TEConomy developed a series of charts similar to Figure X for a variety of health-need related indicators. Figure X, which highlights prostate cancer incidence, is one way to display health needs in a region based on its sub-geographies. Each of the dots in this chart represents a city or county in the Hampton Roads Region, while the size of the dot represents that city/county's total population. Each dot is placed on a line that corresponds with its value for a given health indicator and is colored based on whether it is in the top half (green) bottom half (orange), or bottom quartile (red), when compared to the benchmark comparison counties (either U.S. or Virginia).

Sentara Community Health Needs Assessments

The Patient Protection and Affordable Care Act of 2010 (ACA) requires that, every three years, tax-exempt hospitals create a hospital community health needs assessment alongside community stakeholders. These assessments require an in-depth look at hospital service areas' demographic indicator, locally perceived healthcare issues, and an inventory of current efforts to address healthcare issues. Importantly, they also include a quantitative analysis of actual health care issues and support a 3-year plan to work toward a healthier community.

With approximately 20,000 employees as of December 2018, Sentara Health System is among the largest employers in the Hampton Roads Region.[7] In the summer of 2019, Sentara published updated CHNA's for the vast majority of their hospitals, including each of the large hospitals within the identified geographic footprint. The following seven hospitals encompass this report's study area: Norfolk General, CarePlex, Williamsburg, Leigh, Virginia Beach General, Obici, and Princess Anne.

With 525 beds, Norfolk General Hospital is the Sentara system's largest.[8] The geographic area covered by Norfolk General Hospital is also covered by two of Sentara's large hospitals, Leigh (250 beds) and Virginia Beach General (276 beds). Information from these hospitals' community health needs assessments were used in some instances but were generally duplicative of the findings of Norfolk General study. Although the CarePlex Hospital (224 beds), Obici Hospital (176 beds), Princess Anne Hospital (174 beds), and Williamsburg Regional Medical Centers (145 beds) are smaller, they cover populations not reached by the Norfolk and Virginia Beach General Hospitals.

Priority areas are identified in each of the updated community health needs assessments (Table B-1). In some instances, there are clear overlaps across the region (cancer, mental health, substance abuse, obesity), while in other areas the needs are more unique (women's health in Norfolk, and aging Care in rural areas).

7 *Hampton Roads Economic Development Alliance, Hampton Roads Major Employers, December 2018*
8 *Sentara Healthcare, 2018-2019 Cancer Network Annual Report*

Table B-1. Priority Areas by Sentara Hospital (2019)

Hospital	Specific Area
VB General	Chronic disease, specifically: cancer, heart disease, stroke, diabetes
	Behavioral health, specifically: mental health, substance abuse, opioid addiction
	Social determinants of health, including food access and community partnerships
Leigh	Chronic Disease
	Behavioral health and substance abuse, including opioid addiction
	Social determinants of health and community partnership to improve health
CarePlex	Access to healthcare for low-income and/or underinsured populations
	Opioid crises and community drug use
	Health literacy and community outreach, including cancer, diabetes, and obesity
	Access to healthy and affordable food
Norfolk General	Healthy, connected communities
	Heart health
	Women's health
	Gun violence, accidents, and other trauma
	Mental health and substance abuse
Williamsburg	Heart Health
	Cancer
	Nutrition and Outreach
	Behavioral health, including Alzheimer's Disease and Dementia
Obici	Chronic diseases, especially diabetes, heart disease, and cancer
	Mental health and substance abuse
	Nutrition, including obesity and hunger
Princess Anne	Diabetes
	Obesity
	Heart Disease
	Cancer
	Needs of the Aging
	Stroke

Source: 2019 Sentara Community Health Needs Assessments

Community Health Assessments

Municipal governments also conduct community health needs assessments. According to The Public Health Accreditation board, "the ultimate goal of a community health assessment is to develop strategies to address the community's health needs and identified issues. A variety of tools and processes may be used to conduct a community health assessment; the essential ingredients are community engagement and collaborative participation." In the Hampton Roads region, community health needs assessments are available for both the City of Norfolk and the City of Virginia Beach. Because these analyses covered the same cover area as the more in-depth, hospital level assessments, they were used mainly for contextual and complimentary purposes.

Community Health Improvement Plans

According to the CDC, a community health improvement plan (CHIP) is a "long-term, systematic effort to address public health problems based on the results of community health assessment activities and the community health improvement process. These plans are available for both the City of Norfolk and the City of Virginia Beach. Because these analyses covered the same cover area as the more in-depth, hospital level assessments, they were used mainly for contextual and complimentary purposes.

Other Sources

In addition to the publicly distributed community health needs assessments and improvement plans, TEConomy reviewed news articles, other reports, and interviews with key officials in the region who were familiar with public health issues. These additional sources help provide further context to the population health needs in the region.

SETTING THE CONTEXT:

SUB-AREAS AND SOCIO-ECONOMIC CHARACTERISTICS OF THE HAMPTON ROADS REGION

When assessing population health at the regional level, it is important to balance the nuances between geographic sub-units (counties, cities, and neighborhoods), as well as the socioeconomic characteristics of each of these areas. This examination of regional population health focuses on those areas where the median Hampton Roads city/county fares worse than a benchmark value, as well as those where a significant portion of the region's population lives in a city or county that is worse than the benchmark. The United States median was used as a benchmark in all instances where data was available. In other cases, data for the median Virginia city/county was used.

Much of this report looks at Hampton Roads' health through the city and county level, with a focus on the 14 Virginia cities and counties included in the Virginia Beach–Norfolk–Newport News metropolitan statistical area, as defined by the U.S. Census Bureau.[9] These cities can be seen in Table B-2 right.

Table B-2. Virginia Cities and Counties in the Hampton Roads Region

Counties	Cities
• Gloucester County • Isle of Wight County • James City County • Mathews County • York County	• City of Chesapeake • City of Hampton • City of Newport News • City of Norfolk • City of Poquoson • City of Portsmouth • City of Suffolk • City of Virginia Beach • City of Williamsburg

9 *Although the U.S. Census includes two North Carolina counties in the official MSA definition, only Virginia counties were analyzed. Two additional Virginia counties were added to the metropolitan area in the 2018 definition: Southampton and Franklin. Due to their small size, lack of consistent data, and their distance from the core cities of the metropolitan area, they were not considered in this assessment.*

Demographics

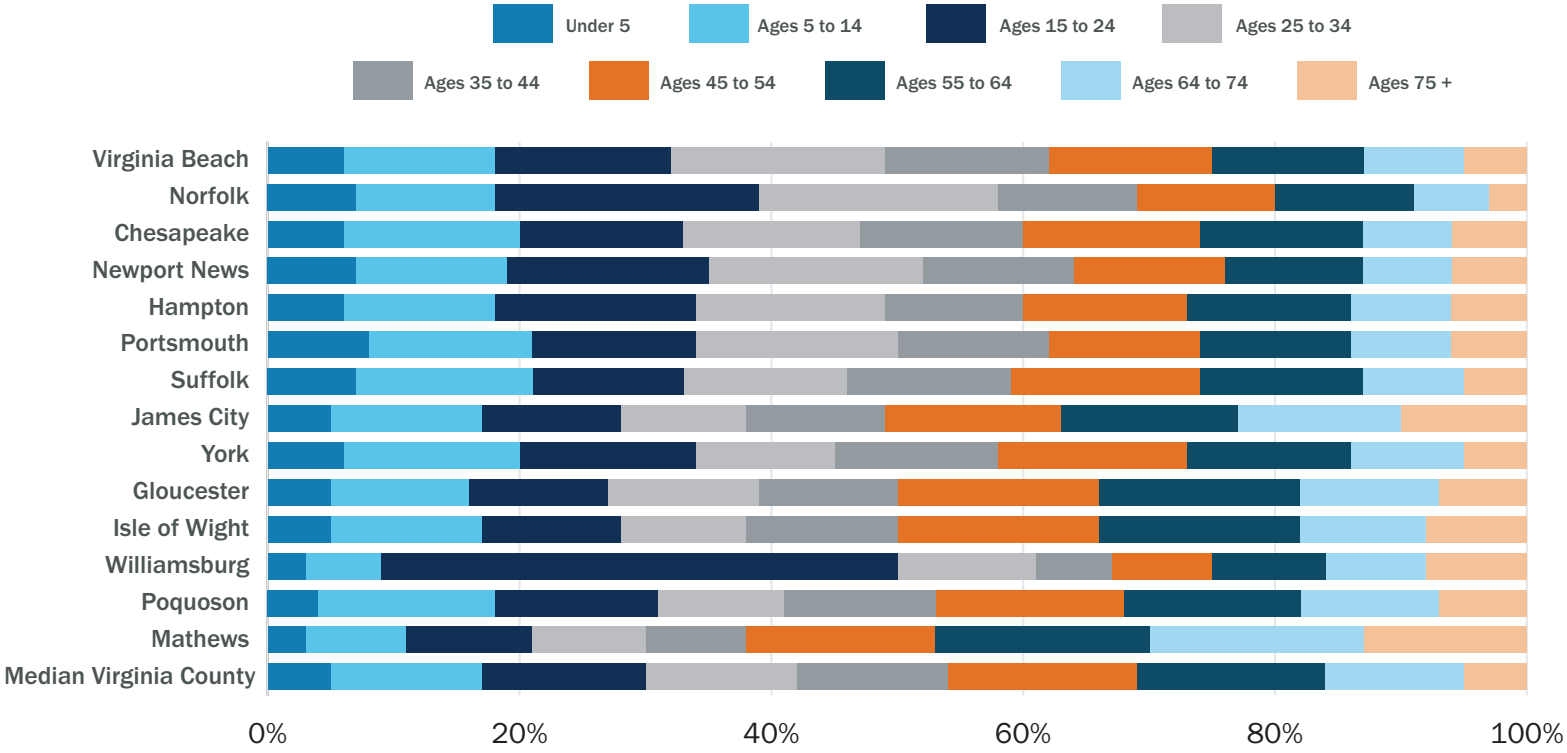
The largest cities in the Hampton Roads MSA are Virginia Beach, Norfolk, and Chesapeake, which combined account for more than half (55.1 percent) of the study population in 2018 (Figure B-3). Over the period from 2010 to 2018, growth appeared to be most rapid in Chesapeake, Suffolk, and James City. Newport News, Hampton, Portsmouth, and Mathews all experienced declines in population from 2010 to 2018.

Figure B-3. Hampton Roads Area by Share of Regional Population and Growth (2010-2018)

Area	Share of Total Population	2018 Population	Change in Population, 2010–2018
Chesapeake	14.4%	242,634	
Gloucester	2.2%	37,349	
Hampton	7.9%	134,313	
Isle of Wight	2.2%	36,953	
James City	4.5%	76,397	
Mathews	0.5%	8,802	
Newport News	10.6%	178,626	
Norfolk	14.4%	244,076	
Poquoson	0.7%	12,190	
Portsmouth	5.6%	94,632	
Suffolk	5.4%	91,185	
Virginia Beach	26.6%	450,189	
Williamsburg	0.9%	14,896	
York	4.0%	67,846	

Source: U.S. Census Bureau's Annual Estimates of the Resident Population, analysis by TEConomy

Figure B-4. Age Distribution by Hampton Roads Area, 2017



Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

The age breakdown of Hampton Roads' geographic subunits can be seen in Figure XX (Table XX) . Children ages 14 and under make up the highest share of the population in Portsmouth, Suffolk, Newport News, and Chesapeake. The share of the total population ages 65 and older is highest in Mathews and James City Counties, and the lowest in Norfolk and Chesapeake.

Table B-3. Age Breakdown by Hampton Roads Area, 2017

Geography	Under 5	Ages 5 to 14	Ages 15 to 24	Ages 25 to 34	Ages 35 to 44	Ages 45 to 54	Ages 55 to 64	Ages 65 to 74	Ages 75 +
Virginia Beach	6.5%	12.4%	13.7%	16.6%	12.9%	13.4%	11.8%	7.5%	5.2%
Norfolk	6.8%	10.6%	21.0%	19.0%	11.3%	10.6%	10.5%	5.9%	4.4%
Chesapeake	6.3%	13.6%	13.5%	14.0%	13.3%	14.4%	12.7%	7.4%	4.7%
Newport News	7.4%	12.5%	16.0%	16.9%	11.7%	12.2%	11.3%	6.9%	5.2%
Hampton	6.2%	11.7%	15.6%	15.5%	11.0%	12.8%	13.1%	8.2%	5.9%
Portsmouth	7.6%	12.6%	13.4%	16.2%	11.6%	12.3%	12.4%	7.8%	6.1%
Suffolk	6.7%	14.0%	12.3%	13.2%	13.2%	14.7%	12.6%	8.2%	5.2%
James City	4.8%	11.9%	11.1%	9.9%	11.0%	13.6%	14.0%	13.2%	10.4%
York	5.5%	14.0%	13.8%	11.2%	12.7%	15.0%	13.1%	8.8%	5.9%
Gloucester	5.3%	11.1%	11.2%	11.7%	11.4%	15.6%	15.9%	10.6%	7.1%
Isle of Wight	5.0%	12.2%	11.5%	10.2%	12.0%	16.0%	15.9%	10.5%	6.9%
Williamsburg	3.4%	6.1%	41.5%	11.3%	6.2%	8.4%	8.6%	8.1%	6.5%
Poquoson	4.2%	13.6%	13.3%	9.6%	11.8%	15.2%	13.9%	10.7%	7.8%
Mathews	2.9%	8.4%	10.0%	9.5%	8.4%	14.7%	16.6%	17.2%	12.3%
Median Virginia County	5.4%	12.0%	13.2%	11.9%	12.4%	14.8%	14.6%	10.8%	7.5%

Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

Race and Ethnicity

The share of the population that is white is less than 50 percent in four of the region's six largest cities. Only four of the region's cities/counties have a share of the population where the white population exceeds that of the median Virginia county: James City and Gloucester, Poquoson, and Mathews Counties. The share of the population that is black is greater than 50 percent in Hampton and Portsmouth. The Hispanic and Latino populations are the largest in the region's largest cities (Newport News, Virginia Beach, and Norfolk), as well as in Williamsburg.

Table B-4. Racial and Ethnic Composition of Hampton Roads Areas, 2017

	Race							Ethnicity	
Geography	White	Black	American Indian	Asian	Pacific Islander	Some other race	Two or more races	Hispanic or Latino	Non-Hispanic or Latino
Virginia Beach	67.2	19.0	0.2	6.6	0.1	1.7	5.1	7.8	92.2
Norfolk	47.4	42.0	0.4	3.6	0.1	2.6	3.9	7.6	92.4
Chesapeake	61.8	29.8	0.2	3.3	0.1	1.4	3.5	5.6	94.4
Newport News	49.0	40.7	0.3	3.2	0.2	1.8	4.8	8.6	91.4
Hampton	41.8	50.1	0.4	2.4	0.1	1.8	3.4	5.4	94.6
Portsmouth	40.4	52.6	0.4	1.3	0.1	1.6	3.6	4.1	95.9
Suffolk	52.1	41.8	0.2	1.6	0.0	0.6	3.7	4.0	96.0
James City	80.3	13.1	0.2	2.5	0.0	0.7	3.2	5.4	94.6
York	76.3	12.8	0.2	5.3	0.3	0.9	4.1	6.0	94.0
Gloucester	87.7	8.4	0.2	0.6	0.0	0.2	2.9	3.3	96.7
Isle of Wight	72.5	22.3	0.3	0.8	0.1	0.6	3.4	2.8	97.2
Williamsburg	73.9	14.6	0.4	5.8	0.0	0.5	4.7	7.7	92.3
Poquoson	94.5	1.0	0.1	1.3	0.0	0.2	2.9	2.4	97.6
Mathews	85.9	10.5	0.3	0.3	0.0	0.0	3.0	0.7	99.3
Median Virginia County	79.4	13.8	0.2	0.9	0.0	0.8	2.3	3.3	96.7

Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

Educational Attainment:

Table B-5 shows the breakdown of educational attainment in each Hampton Roads area in 2017. The share of the population with less than a high school diploma was the highest in Norfolk (12.5 percent) and Isle of Wight (12.4), but this share was still lower than the median VA county. In six of the seven largest Hampton Roads cities, more than half of the population had completed high school and attended some college but did not graduate.

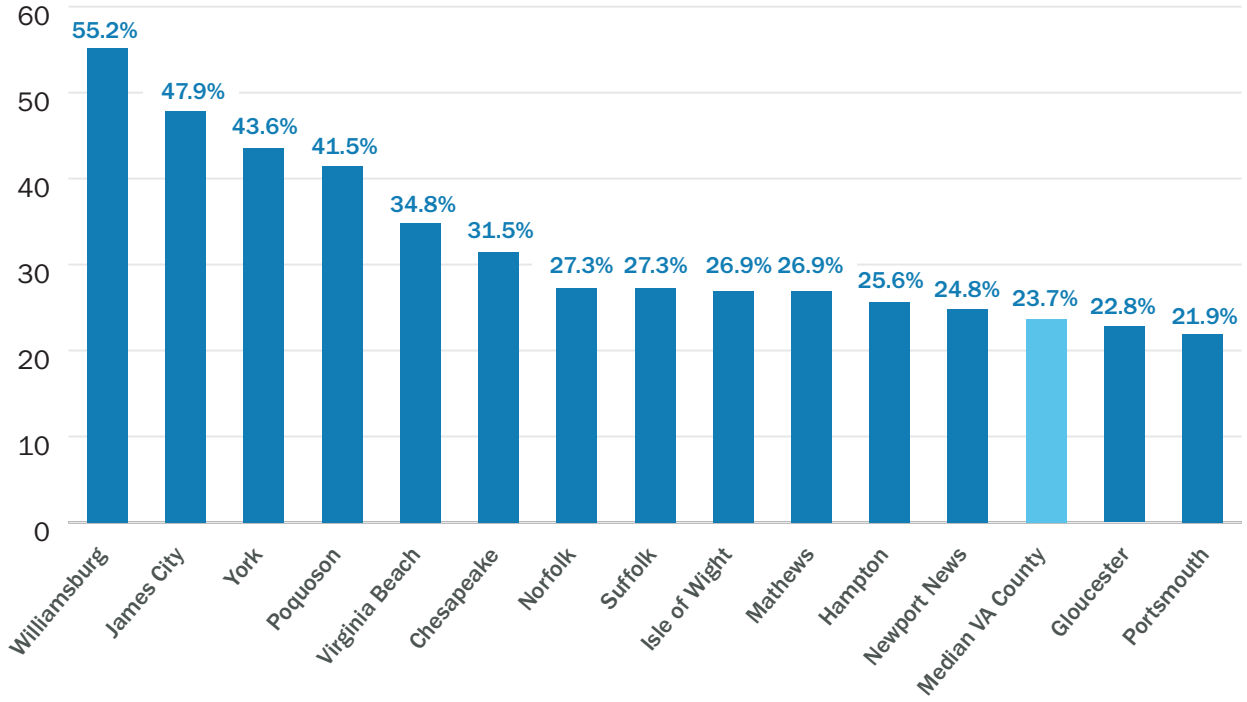
Table B-5. Educational Attainment by Hampton Roads Area, 2017

Geography	Less than HS Diploma	HS Diploma or Some College	Associate degrees	Bachelor's Degrees	Graduate Degrees
Virginia Beach	6.6%	48.0%	10.5%	22.7%	12.1%
Chesapeake	8.0%	51.1%	9.5%	19.6%	11.9%
Norfolk	12.5%	51.8%	8.4%	16.5%	10.8%
Newport News	10.7%	54.7%	9.7%	15.3%	9.5%
Hampton	9.3%	55.7%	9.4%	15.7%	9.9%
Portsmouth	14.0%	56.1%	8.1%	14.3%	7.6%
Suffolk	11.4%	51.9%	9.5%	16.3%	11.0%
James City	5.7%	38.8%	7.5%	26.1%	21.8%
York	5.9%	39.8%	10.6%	23.2%	20.4%
Gloucester	10.2%	56.6%	10.4%	14.3%	8.5%
Isle of Wight	12.4%	51.3%	9.4%	16.1%	10.8%
Poquoson	4.1%	45.1%	9.3%	24.2%	17.3%
Williamsburg	5.8%	33.8%	5.2%	27.8%	27.4%
Mathews	8.6%	59.3%	5.2%	17.2%	9.7%
Median VA County	15.3%	54.8%	7.7%	14.3%	9.4%

Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

Across Hampton Roads region, the share of the total population with at least a bachelor's degree was typically higher in than in the rest of Virginia (Figure B-5). Educational attainment was higher in Virginia Beach (33.8 percent with at least a bachelor's degree) than in the region's other large cities. Williamsburg (55.2 percent), James City County (47.9 percent), and York (43.6 percent) had the highest share of total population with at least a bachelor's degree in 2017. On the other hand, the share of population with at least a bachelor's degree was just 21.9 percent in Portsmouth and 22.8 percent in Gloucester, both lower than the median Virginia County.

Figure B-5. Share of Population with at least a bachelor's degree, by Hampton Roads Area (2017)



Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

Poverty Rate

As Table B-6 shows, the share of all families and people whose incomes in the past 12 months was below the poverty line was highest in Norfolk, Portsmouth, Newport News, and Hampton. In each of these instances, the rate was higher than the median Virginia county (9.5 percent), and all but Hampton had rates higher than the national average (12.3 percent). More than one-in-five families with children in Norfolk, Portsmouth, and Newport News lived below the poverty threshold. The six areas with the highest levels of poverty were also six of the seven most populous in the region.

Table B-6. Poverty rate for families and families with children, Hampton Roads cities and counties (2017)

Geography	Percentage of families whose incomes are below the poverty line	Percentage of families with children whose income is below the poverty line
Norfolk	16.2	25.4
Portsmouth	13.9	23.3
Newport News	12.9	21.8
Hampton	10.9	16.7
Virginia Median	9.5	16.0
Suffolk	9.2	13.7
Chesapeake	7.8	12.1
Mathews	7.4	16.4
Isle of Wight	7.2	13.9
Williamsburg	7.1	12.2
Virginia Beach	5.9	9.4
Gloucester	5.3	10.1
James City	5.1	9.7
York	4.1	7.0
Poquoson	3.3	5.5

Source: 2013-2017 American Community Survey 5-Year Estimates, analysis by TEConomy

Quality of Life

From a health perspective, one way to measure the quality of life in an area is to understand premature deaths, measured as the years of potential life lost before age 75, per 100,000 population and adjusted for age. This information is made available through County Health Ranking & Roadmaps, a collaboration between the University of Wisconsin Population Health Institute and the Robert Wood Johnson Foundation. Each year, County Health Rankings compiles, synthesizes, and analyzes various data points, using the model to then quantify and rank almost every city and county in the United States. Premature death data is based on raw data provided by NCHS and drawn from the National Vital Statistics System (NVSS).

The chart below shows where the years of potential life lost before age 75 per 100,000 population. Portsmouth and Mathews were the only Hampton Roads counties to rank in the bottom quartile of all Virginia counties in premature death, while four other areas (Norfolk, Hampton, Newport, and Gloucester County) had rates higher than the Commonwealth median.

Table B-7. Years of Potential Life Lost by Hampton Roads Area, 2015-2017

Place	Years of Potential Life Lost Rate
Portsmouth City	11,400
Mathews	10,000
Virginia Q3	9800
Norfolk City	9,300
Gloucester	9,100
Hampton City	8,700
Newport News City	8,400
Virginia Median	8,100
Chesapeake City	6,900
Suffolk City	6,600
Poquoson City	6,200
Isle of Wight	6,000
James City	6,000
Virginia Beach City	5,700
York	4,200

Source: County Health Ranking & Roadmaps, analysis by TEConomy

CHRONIC CONDITIONS AND BROADER HEALTH NEEDS IN HAMPTON ROADS

Chronic conditions are those that that last one year or more, require ongoing medical attention, and may be preventable through proper health behaviors or interventions. These conditions are the most common causes of death in the United States, and in the Hampton Roads region.

Furthermore, chronic conditions are a major driver of health care costs. According to research from the Milken Institute, the total direct costs of chronic diseases were more than $1.1 trillion in 2016, equivalent to 5.8 percent of GDP.[10] The chronic diseases with the highest direct costs were cardiovascular conditions ($294.3 billion in annual direct health care expenditures), diabetes ($189.6 billion), and Alzheimer's disease ($185.9 billion).

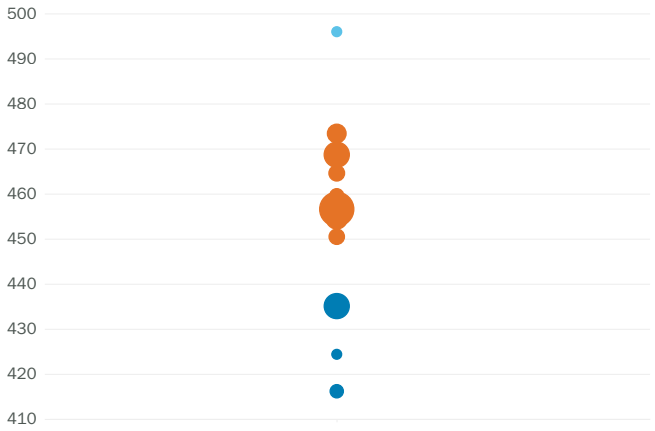
Below we consider chronic conditions relating to the leading disease areas of research found in Hampton Roads – as identified by research grants, publications, clinical trials and clinical excellence – as well as broader health needs found in the region identified by public health reports.

Cancer

According to the National Cancer Institute, cancer is a "term for diseases in which abnormal cells divide without control and are able to invade other tissues.[11] In 2017, the estimated national expenditures for cancer care in the United States were $147.3 billion, with costs expected to increase as the population ages and cancer prevalence increases.[12] Cancer is one of the leading causes of death throughout the country, and is the first or second most common cause of death in each Hampton Road city, along with heart disease.

In general, cancer incidence is more pronounced in Hampton Roads than in the nation as a whole. This is especially true regarding breast cancer, prostate cancer, and cancers incidence among Medicare beneficiaries. According to the Community Health Assessment of the Sentara Norfolk General Hospital service area, cancer rate "trends throughout showed improvement over time with some exceptions."

Figure B-6. All Cancer Incidence Rate by Hampton Roads Area (2011-2015). ***Cases per 100,000 population***

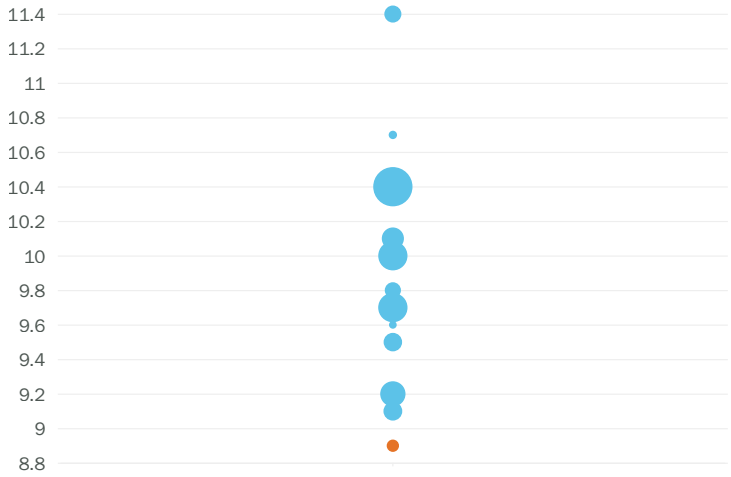


Source: National Cancer Institute data from GHRConnects database, analysis by TEConomy

10 Milken Institute, "The Cost of Chronic Diseases in the U.S." May 2018
11 National Cancer Institute, NCI Dictionary of Cancer Terms
12 National Cancer Institute, Cancer Statistics, Last Reviewed April 2018

Figure B-7. Cancer: Medicare Population by Hampton Roads Area (2017)

Percentage of Medicare beneficiaries who were treated for cancer.



Source: Centers for Medicare & Medicaid Services data from GHRConnects database, analysis by TEConomy

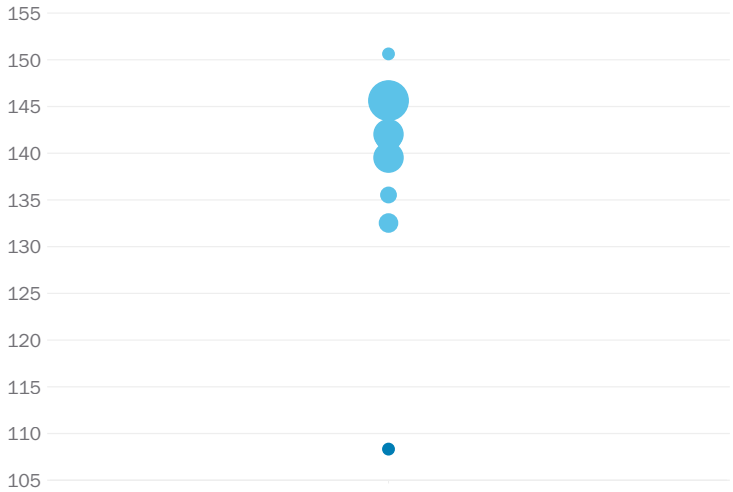
There are 454.7 cases of cancer diagnosed per 100,000 population in the median Hampton Roads county, a rate 9.0 percentage points higher than the median for all U.S. counties (445.7 cases). Nearly three-quarters of Hampton Roads' population lives in a city/county where the cancer incidence is in the bottom 50th percentile among all U.S. counties.

High cancer rates among the region's Medicare population are especially pervasive: Nearly one-in-ten Medicare beneficiaries are treated for cancer in Hampton Roads (9.8), a rate that is noticeably higher than the median U.S. county (7.4 percent). Furthermore, the rate of cancer among Medicare beneficiaries in every city/county in the region ranked among the bottom quartile of U.S. quartiles.

Breast cancer is the second most common cancer among women in the United States. The rate of breast cancer in the median Hampton Roads county was 141.8, noticeably higher than the both the median (119) and the bottom quartile (130.9) rates for all U.S. counties. The breast cancer incidence rate was higher than 130.9 in 13 of the 14 Hampton Roads counties studied: roughly 97.8 percent of the region's population lives in a county where breast cancer incidence rates are in the bottom quartile nationwide.

Figure B-8. Breast Cancer Incidence Rate by Hampton Roads Area (2011-2015)

Breast cancer cases per 100,000 females.

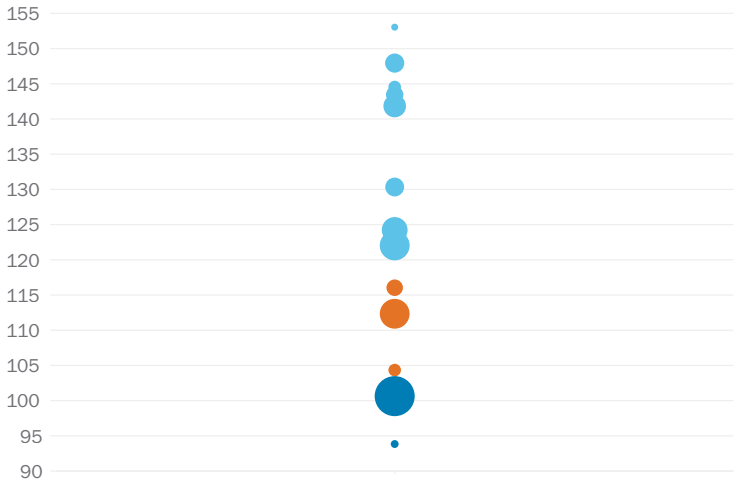


Source: National Cancer Institute data from GHRConnects database, analysis by TEConomy

According to health providers and other experts locally, as reported by *The Virginian-Pilot*, "the area's higher rates can't be blamed on a single factor. They're due to a patchwork of problems – transportation issues, racial disparities, lack of insurance coverage."[13]

13 *The Virginian-Pilot, "Breast cancer rates are especially high in Hampton Roads. There's a patchwork of problems behind the numbers," September 2018*

Figure B-9. Prostate Cancer Incidence Rate by Hampton Roads Area (2011-2015)
Prostate cancer cases per 100,000 males.

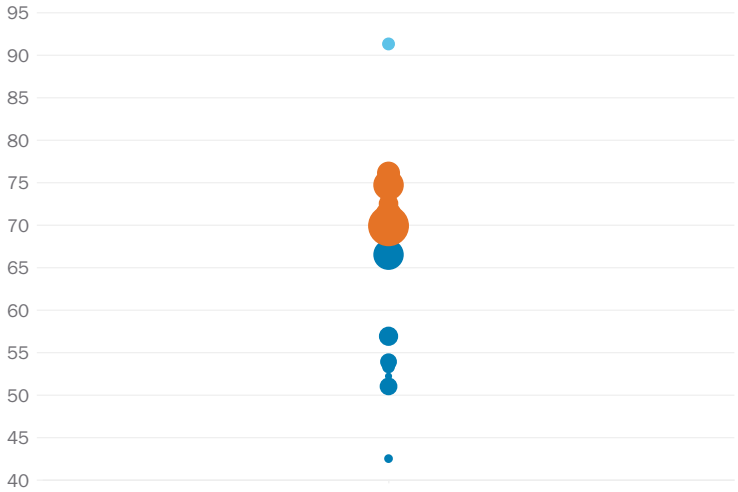


Source: National Cancer Institute data from GHRConnects database, analysis by TEConomy

Another health need facing the Hampton Roads region is the incidence of cancers in the prostate. Nationwide, cancers that affect the prostate are the second most common cancer in men, after skin cancer.[14] The age-adjusted incidence rate for prostate cancer (measured in cases per 100,000 males) in the median Hampton Roads county was 127.3 cases, greater than the cut-off for the bottom quartile of U.S. counties (120.5), and noticeably higher than the median U.S. county value (102.8). In Portsmouth (147.9) and Hampton (141.8), rates of prostate cancer are especially high when compared to counties throughout the nation.

Although lung cancer is quite common nationwide, causing more deaths than any other, they are less pronounced in the Hampton Roads region. The median rate of lung and bronchus cancers was 66.3 cases per 100,000 population, less than the 68.2 median rate among all U.S. counties. However, rates of lung cancer were greater than the median in some of the region's largest cities. Cities with lung and bronchus cancer incidence rates higher than the U.S. county median include Hampton (76.1), Norfolk (74.7), Portsmouth (72.5), Newport News (71.2) and Virginia Beach (69.9).

Figure B-10. Lung and Bronchus Cancer Rate by Hampton Roads Area (2011-2015)
Cases per 100,000 population.



Source: National Cancer Institute data from GHRConnects database, analysis by TEConomy

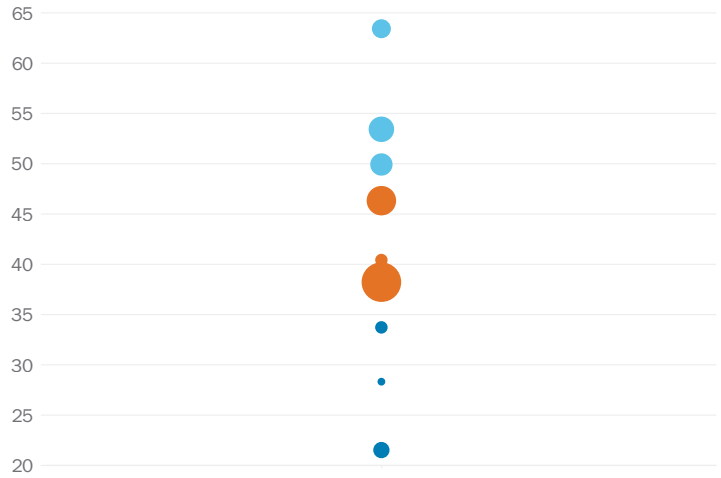
14 Centers of Disease Control and Prevention, "What is Prostate Cancer?," July 2019 "

Cardiovascular Disease

Throughout the United States, cardiovascular diseases – those conditions affecting the structures or functions of the heart – are the leading cause of death for both men and women.[15] More than 630,000 Americans die from heart disease each year—accounting for approximately one in every four deaths. Additionally, heart disease is the leading cause of death for people of most racial/ethnic groups in the United States, including African Americans, Hispanics, and whites.

Figure B-11. Age-Adjusted Hospitalization Rate due to Heart Failure by Hampton Roads Area (2014-2016)

Hospitalization rate due to heart failure per 10,000 population aged 18 years and older.



Source: Virginia Health Information data from GHRConnects database, analysis by TEConomy

More than three-quarters of Hampton Roads' population (77.7 percent) lives in an area where the age-adjusted hospitalization rate for heart failure are in the bottom half of Virginia counties, according to a TEConomy analysis of data from GHRConnects and the VA Department of Health. The rate of heart-failure hospitalization in the median Hampton Roads city/county is 39.5 cases per 10,000 population aged 18 years and older, compared to 36.7 cases in the median Virginia county. In some cities, like Portsmouth (63.4 cases) and Newport News (53.4 cases) this rate falls in the bottom quartile of Virginia counties (48.8 cases).

Figure B-12. Age-Adjusted Death Rate due to Heart Disease by Hampton Roads Area (2013-2017)

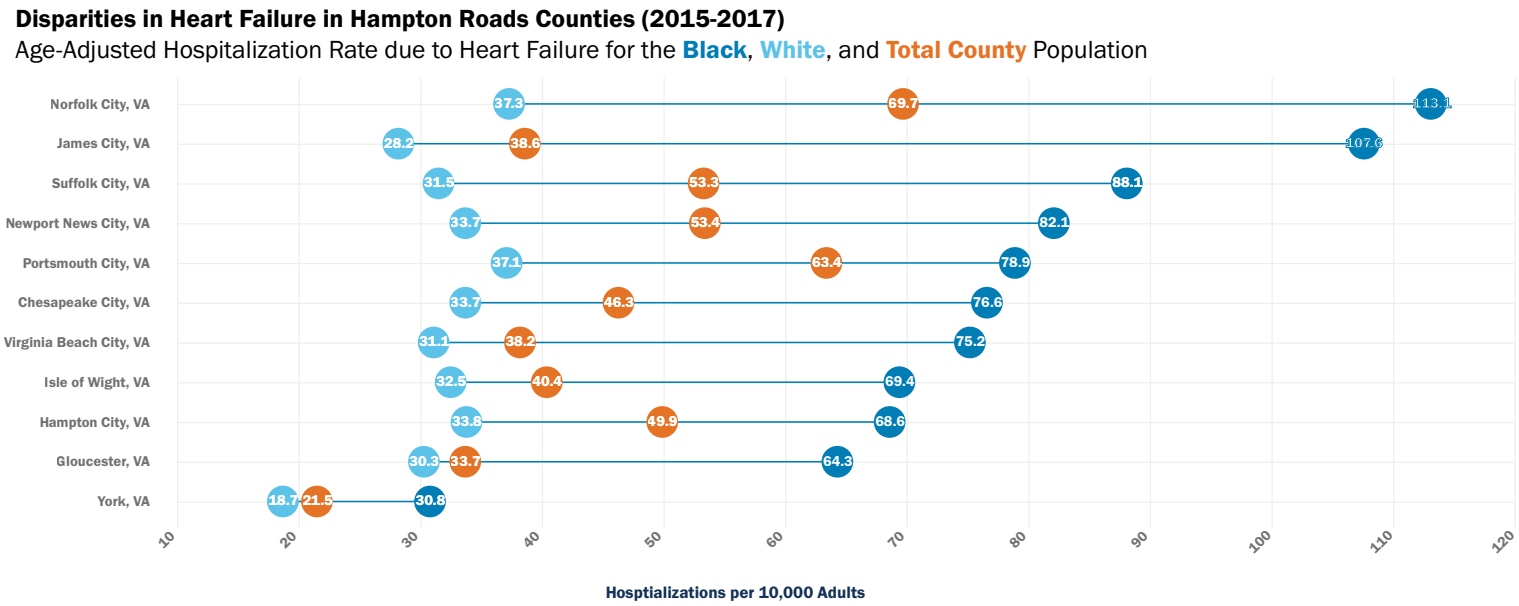
Death rate per 100,000 population due to heart disease.

Source: Virginia Department of Health, Division of Health Statistics data from GHRConnects database, analysis by TEConomy

Within Hampton Roads, there are notable racial disparities in the hospitalization rate due to heart failure: In most Hampton Roads counties, the hospitalization rate for whites was less than half that of Black residents (Figure B-13). Across each Hampton Roads area, the hospitalization rate for blacks due to heart failures is more than twice the rate for whites. For

15 *Centers of Disease Control and Prevention, "Heart Disease Fact Sheet," August 2017*

Figure B-13. Disparities in Heart Failure by Hampton Roads Area, 2015-2018



Source: TEConomy analysis of GHRConnects and Virginia Health Information Data.

example, in Norfolk the age-adjusted hospitalization rate due to heart failure for blacks (113.1 cases per 100,000 population) was more than three-times the rate for whites (37.3 cases).

In addition to a high hospitalization rate for heart failure, several of the region's largest cities also suffers from relatively high age-adjusted death rates due to heart disease. The age adjusted death rate due to heart attack in Portsmouth, Virginia Beach, and Norfolk all ranked in the bottom half of Virginia counties. The age adjusted death rate due to heart disease was especially high Portsmouth was especially high: 200.7, placing it in the bottom quartile of Virginia counties.

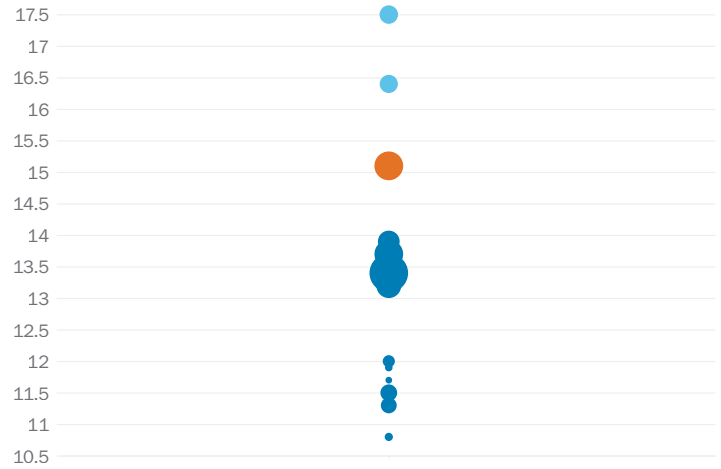
The age-adjusted death rate due to heart disease in the median Hampton Roads city is 146.3 deaths per 100,000 population aged 35 years and older, compared to 152.8 deaths in the median Virginia county. Among Hampton Roads cities, this rate was, by far, the highest in Portsmouth (200.7 deaths per 100,000 population aged 35 years and older).

For the Hampton Roads region's Medicare population, heart failure rates are particularly pronounced in Portsmouth (17.5 percent of all beneficiaries treated for heart failure) and Suffolk (16.4 percent), compared to 14.1 percent receiving treatment in the median U.S. county. However, just 13.9 percent of Medicare Beneficiaries in the median Hampton Roads received

treatment for heart failure, and a relatively small share of the population lives in an area where rates are in the bottom half of U.S. counties.

According to the CDC, nearly one-half of Americans (49%) have at least one of the three main risk factors most commonly associated with heart disease: High blood pressure, high LDL cholesterol, and smoking. Several other medical conditions and lifestyle choices can also put people at increased danger for heart disease, including diabetes, obesity, poor diet, physical inactivity, and excessive alcohol use.

Figure B-14. Heart Failure: Medicare Population by Hampton Roads Area (2017)
Percentage of Medicare beneficiaries who were treated for heart failure.



Source: Centers for Medicare & Medicaid Services data from GHRConnects database, analysis by TEConomy

Among these risks, high blood pressure rates are the most prevalent in Hampton Roads. In five of the seven Hampton Roads cities ranked among the largest 500 in the United States the rate of high blood pressure is in the bottom U.S. quartile.

Rates of excessive drinking are prevalent in Hampton Roads, and are especially stark in two of the region's largest cities. In Virginia Beach, 22.0 percent of adults reported heavy drinking in the 30 days prior to the survey or binge drinking on at least one occasion during that period, and in Norfolk this figure was 21.0 percent. In the median Hampton Roads county, 17.5 percent of adults reported excessive drinking, which is more than the median U.S. county (17.4) or the median Virginia County (16.4).

Figure B-15. High Blood Pressure Prevalence by Hampton Roads Area (2015)
Percentage of adults who have been told they have high blood pressure.

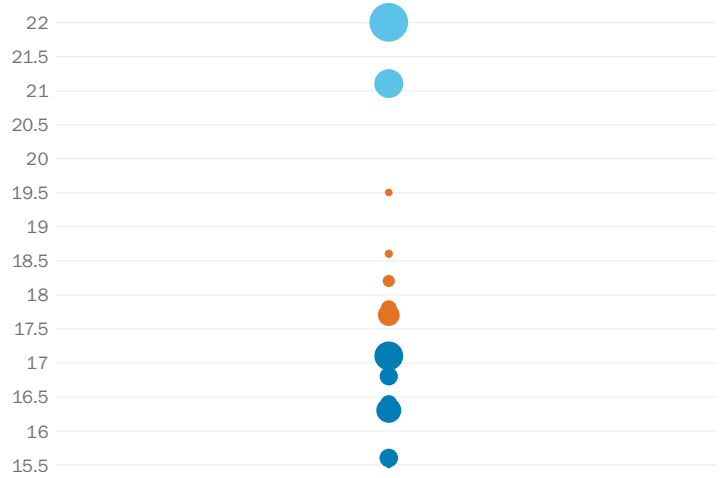
Source: CDC - 500 Cities Project data from GHRConnects database, analysis by TEConomy

The share of adults who smoke cigarettes is higher than the U.S. county median in five of the region's cities: Portsmouth (22.3), Norfolk (20.0

percent), Newport News (19.7), Hampton (19.4), and Suffolk (19.1 percent). Portsmouth is the only city that ranks in the bottom quartile of U.S. counties, however, more than half of the region's population lives in an area that is among the bottom half of all U.S. counties.

Figure B-16. Adults who Drink Excessively by Hampton Roads Area (2016)

Percentage of adults who reported heavy drinking



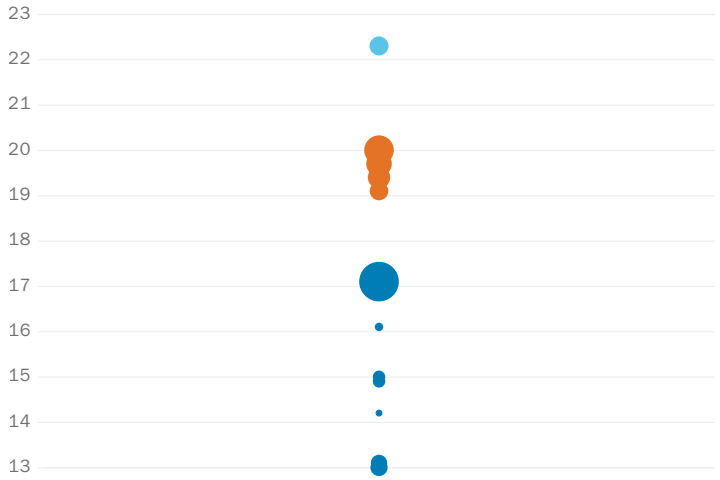
Source: County Health Rankings data from GHRConnects database, analysis by TEConomy

Except for Virginia Beach and some of the region's smaller counties and cities, obesity ranks as another area of concern for the Hampton Roads population. In the median Hampton Roads city, 34.3 percent of adults ages 20 and older are obese, compared to 33.0 in the median U.S. county. In some cities, like Portsmouth (39.1 percent), Isle of Wight (39.1), and Hampton (37.9 percent), the obesity rate was in the bottom quartile of U.S. counties (36.5 percent).

Overcoming these risks and preventing chronic diseases is an important element of the region's community health. A survey of more than 200 public-health stakeholders in the region, chronic disease prevention (e.g., obesity, heart disease, and diabetes) was the second most prioritized health issue (38 percent of respondents), trailing only safe communities (67 percent).

Figure B-17. Adults who Smoke by Hampton Roads Area (2016)

Percentage of adults who currently smoke cigarettes

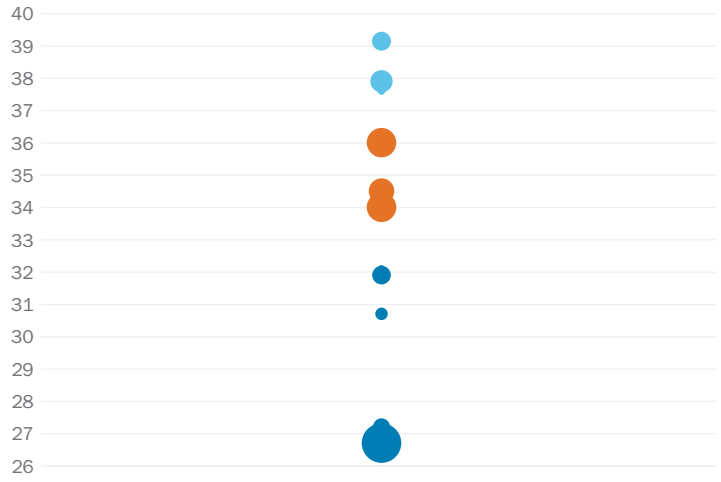


Source: County Health Rankings data from GHRConnects database, analysis by TEConomy

Although chronic illnesses such as heart disease are pervasive throughout the region's cities and counties, there are also significant disparities at the neighborhood level. According to City of Norfolk's Community Health Improvement Plan (CHIP), "Unhealthy behavior such as smoking, no leisure time for physical activity, and obesity as well as poor health outcomes such as high blood pressure, high cholesterol and diabetes disproportionately affect certain Norfolk neighborhoods with higher levels of poverty."

Figure B-18. Adults 20+ Who Are Obese by Hampton Roads Area (2016)

Adults aged 20 and older who are obese according to their BMI



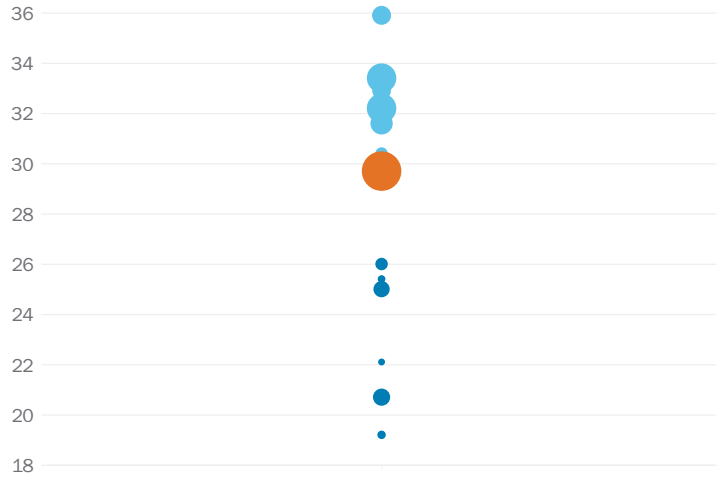
Source: CDC - 500 Cities Project data from GHRConnects database, analysis by TEConomy

Diabetes

Diabetes is a chronic health condition that occurs when blood glucose (or blood sugar) is too high.[16]Insulin, a hormone made by the pancreas, helps glucose, the main source of energy from eaten food, get into cells to be used for energy. The bodies of individuals with diabetes either struggle to produce enough insulin, or their body does not use insulin well. In these instances, glucose stays in the blood, and energy does not reach the cells.

Figure B-19. Diabetes: Medicare Population by Hampton Roads Area (2017)

Adults aged 20 and older who are obese according to their BMIPercentage of Medicare beneficiaries who were treated for diabetes.



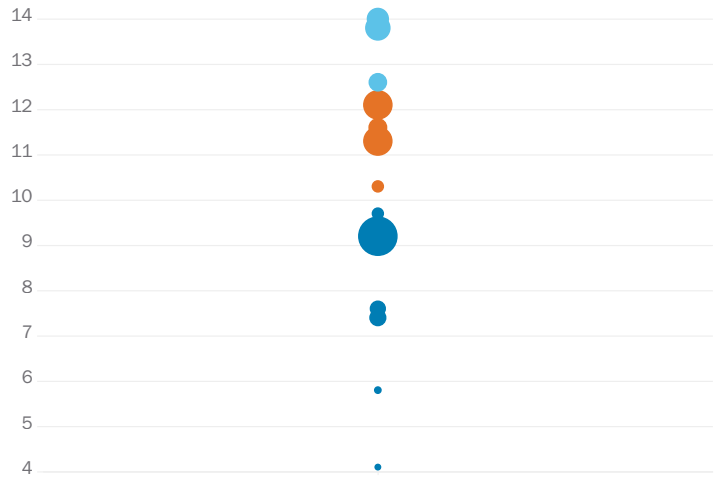
Source: Centers for Medicare & Medicaid Services data from GHRConnects database, analysis by TEConomy

The most common form of diabetes is Type 2, which occurs most frequently in middle-aged and older people. Type 2 diabetes is most likely to develop in those ages 45 or older, have a family history of diabetes, or are overweight. Physical inactivity, race, and certain health problems such as high blood pressure also affect chances of developing type 2 diabetes.

In the median Hampton Roads county, 10.8 percent of adults ages 20 and older had diabetes, a rate that is nearly a full percentage point higher than median U.S. county (9.9 percent). Diabetes rates are particularly high in some of the region's largest cities: Newport News (13.8 percent), Suffolk (12.6 percent) and Newport News (12.1 percent). Each of these three cities falls in the worst quartile of all U.S. counties (12.1 percent).

Figure B-20. Adults 20+ with Diabetes by Hampton Roads Area (2016)

Adults aged 20 and older who have ever been diagnosed with diabetes.



Source: Centers for Disease Control and Prevention data from GHRConnects database, analysis by TEConomy

16 *https://www.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes*

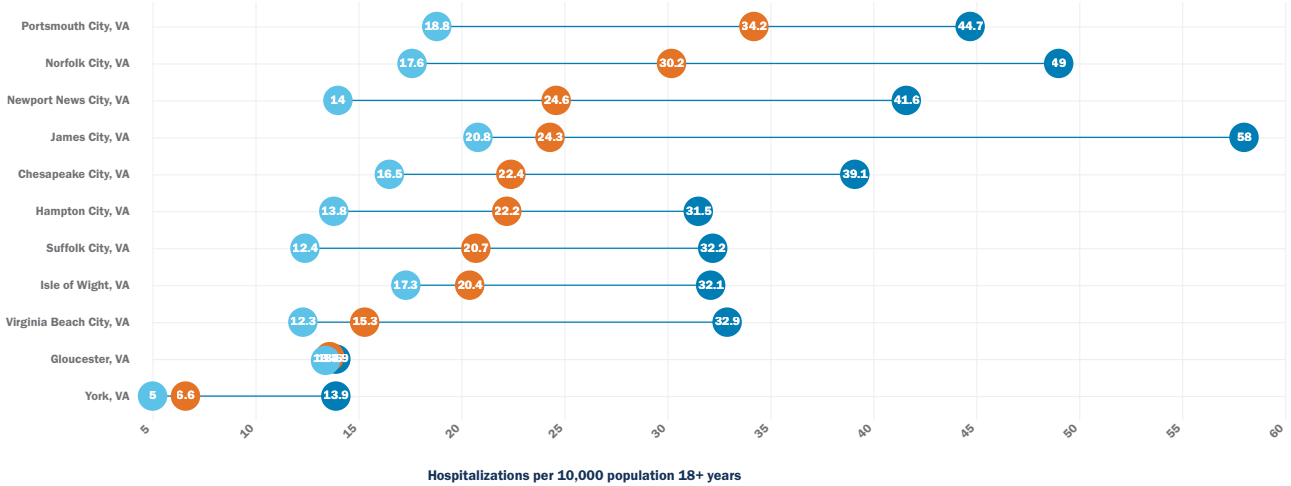
This high share of adults with diabetes is in alignment with elevated rates of hospitalization visits. In the median Hampton Roads county, the age adjusted hospitalization rate due to Diabetes (20.7) was higher than the Virginia median (17.5). In Norfolk (30.2) and in Portsmouth (34.1), the rate was in the worst quartile of all Virginia counties (28.1). Notably, these two cities also rank in the bottom quartile of Virginia counties in the age-adjusted hospitalization rate due to short-term and long-term complications of diabetes. Norfolk and Portsmouth rank in the bottom half of Virginia counties in the age-adjusted hospitalization rate due to uncontrolled diabetes.

Among the region's population, Hampton Roads' Medicare beneficiaries are particularly susceptible to diabetes: 29.7 percent of the Medicare recipients in the median Hampton Roads county have diabetes, compared to 27.1 percent in the median U.S. county. Nearly two-thirds (65.0 percent) of the region's population lives in a county where Medicare diabetes rates are in the bottom half of U.S. counties.

Hampton Roads' high levels of diabetes are impacted by stark racial disparities (Figure B-21). In the median Hampton Roads County, the diabetes hospitalization rate is more than 2.5 times that of whites. This is especially clear in Newport News, Norfolk, Portsmouth, the three major cities where diabetes rates and complications are most evident. In Newport News, the age-adjusted diabetes hospitalization rate for the black population is 3.0x that of the white population. In Norfolk, the rate for the black population is 2.8x, and in Portsmouth, the rate is 2.4x.

Figure B-21. Racial Disparities in Diabetes Rates by Hampton Roads area (2015-2017)

Disparities in Diabetes for the Black, White, and County Total Population (2015-2017)
Changes in Age-Adjusted Diabetes Hospitalization Rates by Hampton Roads County



Source: Virginia Health Information data from GHRConnects database, analysis by TEConomy

Stroke (Neurology):

Strokes occur when the blood flow to the brain is disrupted in one of two ways: a blocked artery (ischemic stroke, accounting for roughly 80 percent of all strokes) or the leaking or bursting of a blood vessel (hemorrhagic stroke).[17]

Figure B-22. Adults who Experienced a Stroke by Hampton Roads Area (2016)

Percentage of adults who have ever been told by a health care provider that they had a stroke.

Source: CDC - 500 Cities Project data from GHRConnects database, analysis by TEConomy

According to the Mayo Clinic, potentially treatable stroke risk factors include obesity, physical inactivity, binge drinking, or illicit drug use. Medical factors that may contribute to stroke include elevate blood pressure, cigarette smoking or exposure, high cholesterol, diabetes, cardiovascular disease, or family histories. There is also a higher prevalence of strokes among the elderly, men, and African Americans. Up to 80 percent of all strokes are preventable, the CDC notes, and there are numerous efforts to ensure that the risks and symptoms of strokes are properly communicated to the public.[18]

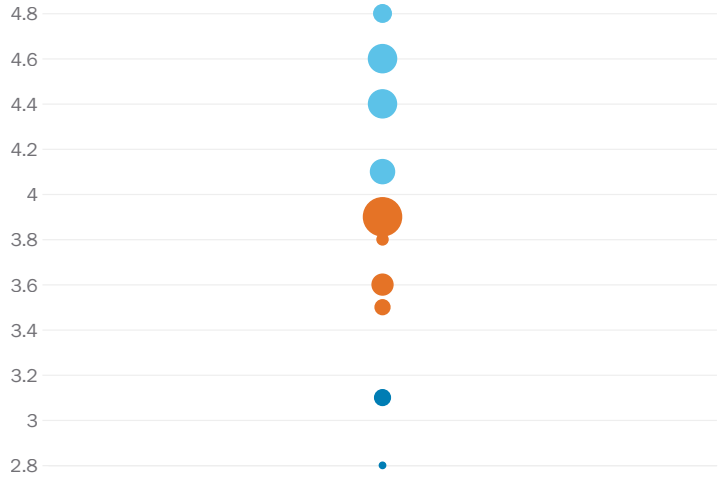
In the median Hampton Roads county, 3.9 percent of Medicare beneficiaries are treated for stroke, compared to 3.4 percent in the median U.S. county. Stroke rates among Medicare beneficiaries are elevated throughout the region, with 95 percent of the population living in a county where stroke rates were in the worst 50th percentile of U.S. counties.

Stroke rates among the general population are also higher than average in four of the region's seven largest cities. Among the country's largest 500 cities, Hampton (3.6) and Portsmouth (4.0) rank among the bottom quartile in the share of adults experiencing a stroke. Suffolk, Norfolk, and Newport News each rank in the bottom half among the country's largest 500 cities.

17 *https://www.mayoclinic.org/diseases-conditions/stroke/symptoms-causes/syc-20350113*
18 *Centers of Disease Control and Prevention, "Stroke Communications Kit," October 2019*

Figure B-23. Stroke: Medicare Population by Hampton Roads Area (2017)

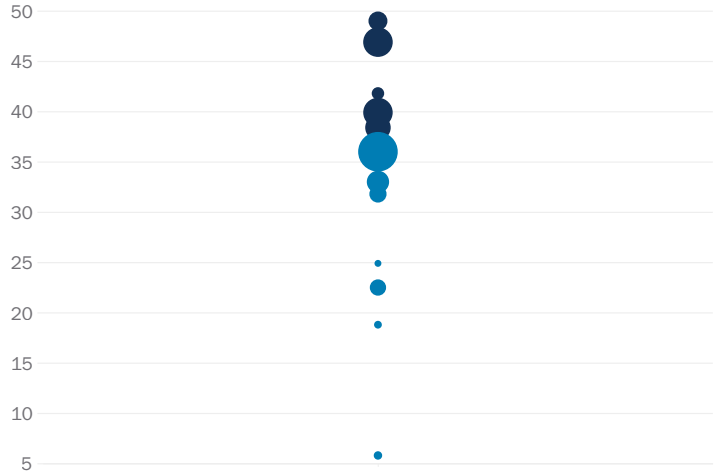
Percentage of Medicare beneficiaries who were treated for stroke.



Source: Centers for Medicare & Medicaid Services data from GHRConnects database, analysis by TEConomyy

Figure B-24. Age-Adjusted Death Rate due to Cerebrovascular Disease (Stroke) by Hampton Roads Area (2013-2017)

Age-adjusted death rate per 100,000 population due to cerebrovascular disease and stroke



The age-adjusted death rate due to cerebrovascular disease in the median Hampton Roads area is 36.1, slightly lower than the U.S. value (37.6). Rates of death due to stroke and stroke-like diseases were the highest in Portsmouth (49.0) and Norfolk (46.9), though just under half of the region's population lives in an area that is in the bottom 50th percentile.

Reproductive, Fetal, and Maternal Health

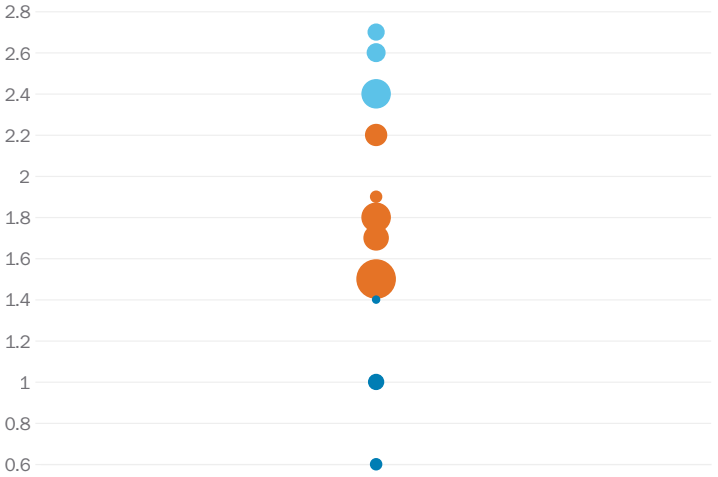
A commonly used indicator to assess the overall health status of a community is the infant mortality rate. The infant mortality rate (deaths per 1,000 live births for infants within their first year of life) in the median Hampton Roads area was 5.8, slightly lower than the U.S. value (5.9). However, the infant mortality rates in in major cities like Norfolk (10.4) and Chesapeake (7.6) and outlying counties like Mathews (14.5) and Williamsburg (13.5) were very high and could be considered an area of concern.

Figure B-25. Babies with Low Birth Weight by Hampton Roads Area (2013-2017)
Percentage of births in which the newborn weighed less than 2,500 grams

Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

Low birthweight is among the leading causes of death among infants in the United States, and babies born with low birthweights are more likely to have health problems later in life.[19] "Poor birth outcomes —such as preterm delivery, low birth weight, and infant mortality —result from complex interactions of social, economic, environmental, and other factors that precede pregnancy and directly and indirectly influence health," according to research by the Association of Maternal and Child Health Programs.[20]

Figure B-26. Babies with Very Low Birth Weight by Hampton Roads Area (2013-2017)
Percentage of births in which the newborn weighed less than 1,500 grams



Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

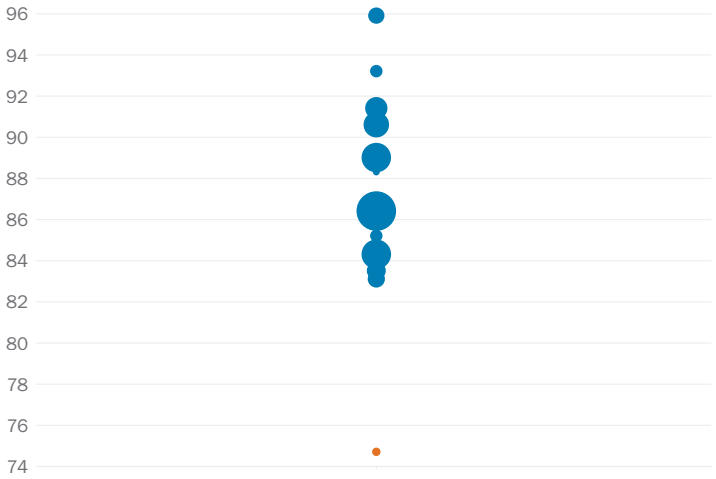
19 *Centers of Disease Control and Prevention, "Singleton Low Birthweight Rates, by Race and Hispanic Origin: United States, 2006–2016," March 2018*

20 *Association of Maternal and Child Health Programs, "The Power of Prevention for Mothers and Children: The Cost Effectiveness of Maternal and Child Health Interventions," July 2018*

The CDC differentiates between low-birthweights (LBW), the percentage of births in which the newborn weighed less than 2,500 grams (5 pounds, 8 ounces), and very-low birthweights (VLBW), where newborns weighed less than 1,500 grams (3 pounds, 5 ounces).[21] In both instances, Hampton Roads cities and counties fared poorly when compared to the national average.

Figure B-27. Mothers who Received Early Prenatal Care by Hampton Roads Area (2015)

Percentage of births to mothers who began prenatal care in the first trimester of their pregnancy.



Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

Nearly one-in-10 of babies (9.5 percent) born in the median Hampton Roads county had a low birthweight, compared to 8.3 percent nationally. Meanwhile, 1.8 percent of babies born in the median Hampton Roads county had a very low birthweight, greater than the national value of 1.5 percent.

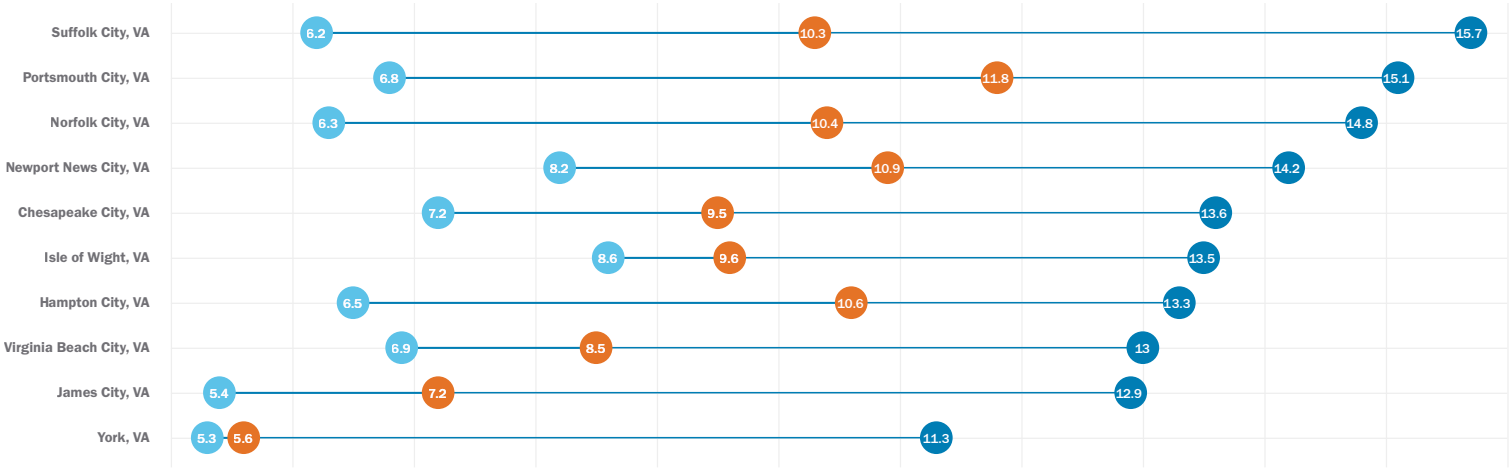
It is worth noting, however, the share of mothers receiving prenatal care was very high in the region. In 13 of the 14 Hampton Roads cities and counties, the share of mothers receiving pre-natal care was higher than the Virginia median (81.0 percent) or the U.S. Value (77.0 percent). Only in Williamsburg, one of the region's smallest areas, did the share of mothers receiving pre-natal care fall below these figures (74.7 percent).

On average, the share of Black babies born with low birthweight is more than twice the rate for white babies throughout Hampton Roads (Figure B-28). Disparities in fetal health were especially stark in Suffolk, Portsmouth, and Norfolk. These cities were also home to some of the highest overall shares of low-weight births, suggesting the broad influence of these racial disparities.

21 Centers of Disease Control and Prevention, "Singleton Low Birthweight Rates, by Race and Hispanic Origin: United States, 2006–2016," March 2018

Figure B-28. Racial Disparities in Natal Health by Hampton Roads Area (2017)

Disparities in Natal Health in Hampton Roads Counties (2017)
Share of Babies Born With Low Birthweight for the **Black**, **White,** and **Total County** Population

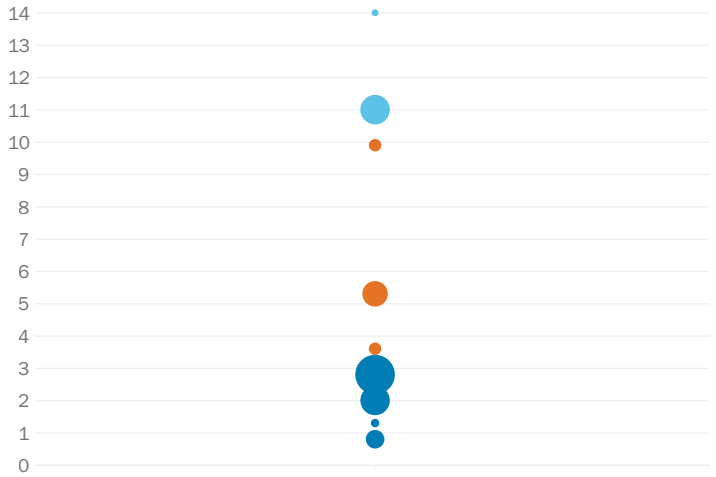


Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

Infant, Early Childhood, and Adolescent Health

When compared to other counties in Virginia, the Hampton Roads region fares relatively well regarding children's health. No Hampton Roads city ranks lower than the U.S. county median in the share of children living in households that experience food insecurity. Likewise, the vast majority of the region's population lives in a city or county where the share of children with health insurance is in the top half of U.S. counties.

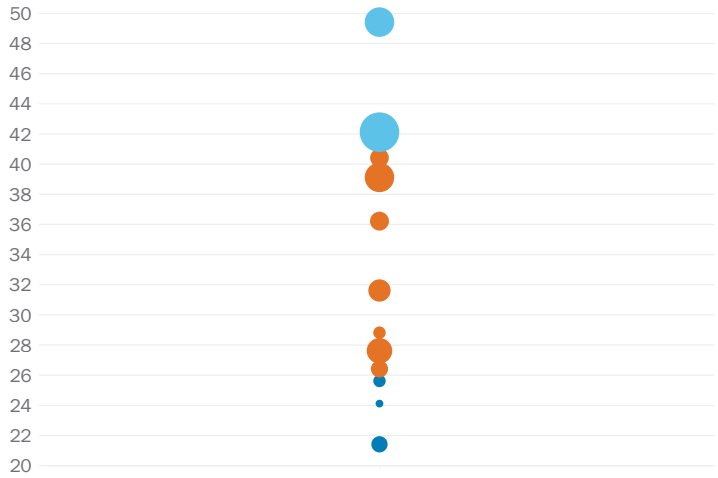
Figure B-29. Child Abuse Rate by Hampton Roads Area (2017)
Number of incidents of abuse or neglect per 1,000 children under 18 years of age



Source: Virginia Department of Social Services data from GHRConnects database, analysis by TEConomy

However, challenges do appear in two areas of children's health: child abuse, and hospitalization due to pediatric mental health. According to the CDC, children who experience abuse and other adverse experiences are at increased risk for negative health consequences and certain chronic diseases as adults.[22] In Norfolk, there were 11.0 incidents of abuse or neglect per 1,000 children, which in the bottom quartile of Virginia counties. The child abuse rate in rural counties like Mathews and Gloucester is also in the bottom quartile, suggesting that abuse is not just an urban phenomenon.

Figure B-30. Age-Adjusted Hospitalization Rate due to Pediatric Mental Health by Hampton Roads Area (2015-2017)
Age-adjusted hospitalization rate due to mental health per 10,000 population under 18 years



Source: Virginia Health Information data from GHRConnects database, analysis by TEConomy

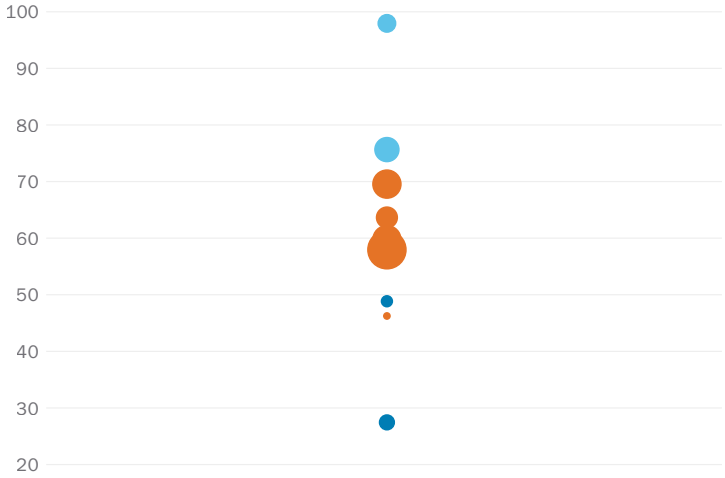
In the median Hampton Roads county, the age-adjusted hospitalization rate due to mental health per 10,000 population under 18 years is 31.6, compared to 26.4 in the median Virginia county. The vast majority of Hampton Roads' population lives in a county where hospitalization rates for pediatric mental health are in the worst quartile of Virginia Counties.

22 Centers of Disease Control and Prevention, "Child Abuse Prevention," August 2019

Adult Mental Health

While the children of Hampton Roads stand out for high levels of hospitalization due to mental health challenges, adults face similar challenges. Mental health was identified as a key priority area throughout all Sentara Community Health Needs Assessments. Additional analysis finds that the associated complications due to mental health are multi-faceted and not easily solved within the confines of a doctor's office.

Figure B-31. Age-Adjusted Hospitalization Rate due to Mental Health by Hampton Roads Area (2015-2017)



Source: Virginia Health Information data from GHRConnects database, analysis by TEConomy

According to one interview with a public health professional, accessing behavioral and mental health care is an issue in two ways. "First, mental illness is highly stigmatized, which limits willingness to seek treatment. Second, mental health crises are also very disruptive to these communities. The lack of preventative care, high rates of comorbid substance use, and increased potential for police involvement can make these events very traumatic and can be disruptive even for those who are only peripherally involved (e.g., neighbors)."

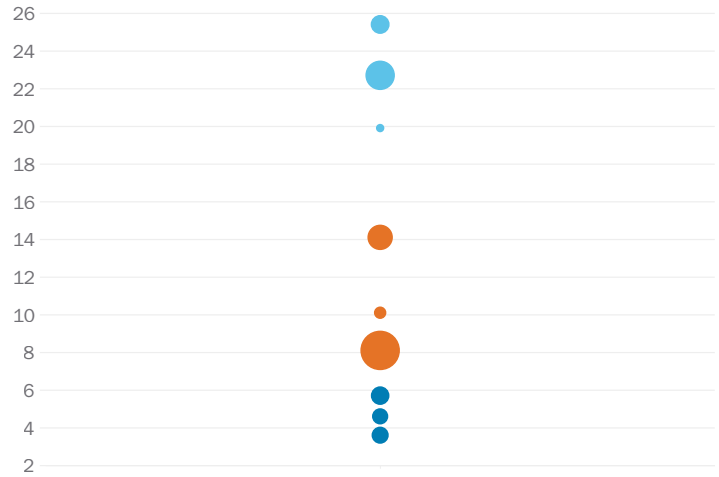
In Portsmouth (97.9 cases per 10,000 population) and Newport News (75.6), the age adjusted hospitalization rate due to adult mental health was in the bottom quartile of Virginia counties (71.7). Several other large cities – including Norfolk (69.5), Hampton (63.6), Suffolk (59.9), and Virginia Beach (57.9) – also had mental health hospitalization rates higher than the median Virginia county (55.3).

Despite high levels of hospitalization for mental health, the suicide death rates in the region are relatively low. Only two of the 14 Hampton Roads counties have age-adjusted suicide death rates that are below the Virginia county median (13.2 age-adjusted deaths per 100,000 population due to suicide), according to data from GHRConnects and the Virginia Department of Health's Division of Health Statistics.

Sexual Health

Although teenage pregnancies are at an all-time low nationally, with downward trends spanning all 50 states and racial/ethnic groups, they are not without significant social and economic costs. The CDC estimates that teenage pregnancy accounts for more than $9 billion in costs to U.S. taxpayers. Additionally, it has already been established that the region suffers from high rates of diabetes and obesity. "Women who are overweight or obese before pregnancy are at higher risk for maternal and infant morbidity and have longer hospital stays with higher delivery-related health care costs"

Figure B-32. Teen Pregnancy Rate by Hampton Roads Area (2017)
This indicator shows the number of pregnancies per 1,000 females aged 15-17 years.



Source: Virginia Department of Health, Division of Health Statistics data from GHRConnects database, analysis by TEConomy

According to the National Council of State Legislatures, teenage mothers are also more likely to live in poverty and depend on public assistance, and less likely to earn their high school diploma or other advanced education.[23] Teenage pregnancies can also exacerbate cyclical poverty, where "children born to teen parents are more likely to have lower school achievement, enter the child welfare and correctional systems, drop out of high school and become teen parents themselves, compared to children born to older parents."

Teen pregnancy rates are elevated in several of the region's core cities: Portsmouth (25.4), Norfolk (22.7), Hampton (14.1), and Newport News (14.1) all rank in the bottom quartile of Virginia counties in the number of pregnancies per 1,000 females aged 15-17 years.

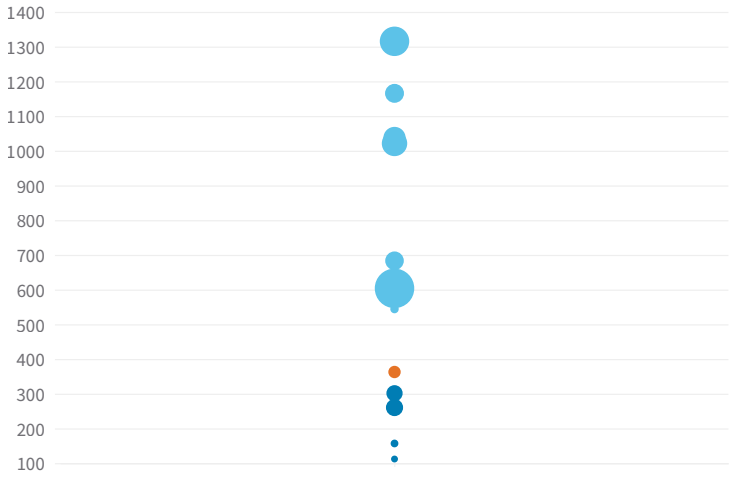
Beyond low-birthweights and elevated levels of teenage pregnancy, the region also suffers from higher-rates of sexually transmitted infections. The incidence rates of two STI's – Chlamydia and Gonorrhea – are especially high and an area of concern. Taken together, this suggests there is room to improve the behavioral health around sexual activity in the region.

Chlamydia is a sexually transmitted disease that can infect both men and women, however, it can cause serious damage to a woman's reproductive system and make it more difficult or impossible for her to get pregnant later in life.[24] Furthermore, chlamydia can also cause a potentially fatal ectopic pregnancy (pregnancy that occurs outside the womb).

23 National Conference of State Legislatures, "Teen Pregnancy Prevention," October 2018
24 Centers of Disease Control and Prevention, "Chlamydia Fact Sheet," January 2014

Figure B-33. Chlamydia Incidence Rate by Hampton Roads Area (2017)

Chlamydia incidence rate in cases per 100,000 population.



Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

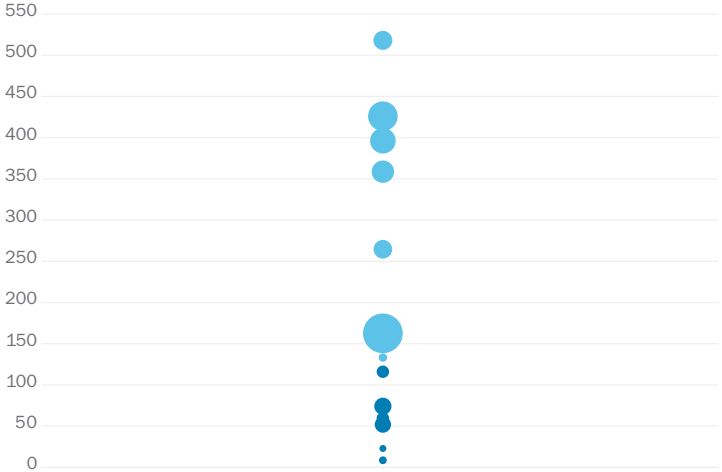
There were 567.8 cases of Chlamydia per 100,000 population in the Median Hampton Roads county, much higher than the 303.3 cases in the Virginia median and the 497.3 cases for the United States median. The rate of chlamydia is more than twice the national value in three Hampton Roads cities – Norfolk (1316.2 cases), Portsmouth (1166.3), and Hampton (1037.7).

The Norfolk Community Health Improvement Plan finds similar challenges around sexual health. "The morbidity and new infection rates of sexually transmitted infections (STI) are significantly higher in Norfolk than for the Eastern Virginia Region or for Virginia statewide," the plan notes. "While this is true for all the STIs – HIV/AIDs, syphilis, gonorrhea and chlamydia – **"chlamydia has one of the highest morbidity rates and these rates have continued to increase over the last fifteen year."**

Gonorrhea is a very common sexually transmitted disease, especially among young people between the ages of 15 and 24 years, and any sexually active person is in danger of obtaining the disease.[25] Gonorrhea can infect men and women, causing infections in the genitals, rectum, and throat. The disease can be cured with the right treatment, but untreated gonorrhea can cause serious and permanent health problem.

Figure B-34. Gonorrhea Incidence Rate by Hampton Roads Area (2016)

Gonorrhea incidence rate in cases per 100,000 population.



Source: Virginia Department of Health, Division of Health Statistics; CDC data from GHRConnects database, analysis by TEConomy

Similar to Chlamydia, there are several areas that stand out for especially high levels of gonorrhea incidence. In the median Hampton Roads county,

25 Centers of Disease Control and Prevention, "Gonorrhea," January 2014

the incidence of gonorrhea was 147.6 cases per 100,000 population, greater than the 145.8 cases figure for the United States. In several Hampton Roads cities, the rates of gonorrhea were very high, especially in Norfolk (425.7 cases), Portsmouth (517.7 cases), and Newport News (395.9 cases).

The Norfolk CHIP also points to existing programs, initiatives, and policies related to sexual health in Hampton Roads. Some examples include:

- AIDS Care Center for Education and Support Services Teen Outreach Program: Provides a coalition of membership organizations dedicated to enhancing adolescent pregnancy prevention efforts by educating school-aged children and their parents; encouraging collaborative community involvement to increase the effectiveness of teen pregnancy prevention efforts; assisting in the coordination of services to teens through networking and building support systems within the community; and offering technical assistance and support to enhance programs provided by member organizations.

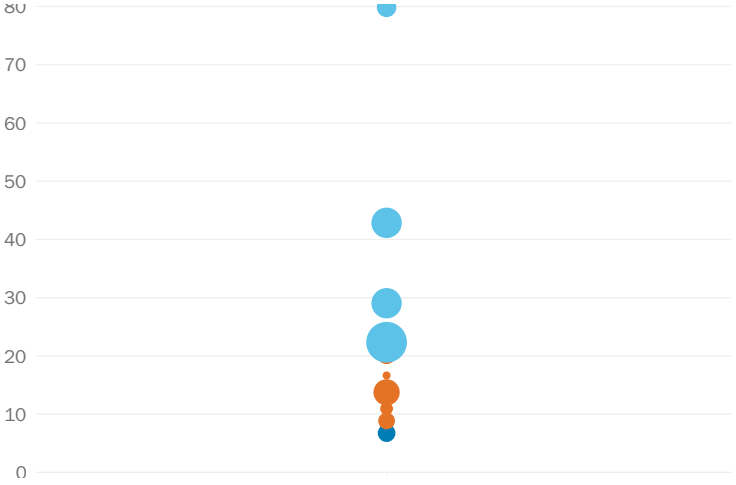
- New Beginnings Development Services - Transitional Home for pregnant girls ages 13-18 with case management, crisis intervention, parenting and self-sufficiency classes, self-esteem, and budgeting, education and employment counseling are just some of the services.

- Pride in Parenting, The UP Center - Provides information and support to care for a teen mother and her baby through the first year and how to help the baby grow and develop.

Substance Abuse

This analysis has already determined that legal substances such as alcohol and tobacco are higher than the nation in several of Hampton Roads' largest cities. Perhaps more troubling, opioids, heroin, and fentanyl are a significant health challenges not only to these cities, but to the region as a whole.

Figure B-35. Emergency Department Admission Rate due to Heroin by Hampton Roads Area (2017)
Heroin-related emergency department visit rate per 100,000 population.



Source: Virginia Department of Health data from GHRConnects database, analysis by TEConomy

Due to the growing number of opioid overdoses throughout the Commonwealth, Virginia Health Commissioner Marissa Levine declared the crisis an official public health emergency in November 2016.[26] Communities are taking action across several areas to combat the epidemic: prevention (legal and illegal), harm reduction (such as naloxone/Narcan strategies), treatment, and culture change. However, significant challenges remain as it pertains to addressing the opioid crisis, especially as users switch to cheaper and more lethal alternatives like heroin and fentanyl.

Figure B-36. Death Rate due to Fentanyl and/or Heroin Overdose by Hampton Roads Area (2017)
Death rate per 100,000 population due to fentanyl and/or heroin overdose.

Source: Virginia Department of Health data from GHRConnects database, analysis by TEConomy

The heroin-related emergency department visit rate was 18.4 visits per 100,000 population in the median Hampton Roads county, compared to 8.1 visits per 100,000 population in the median Virginia county. More than 90 percent of the region's population lives in a county where the heroin-related emergency department visit rate exceeded the Virginia county median.

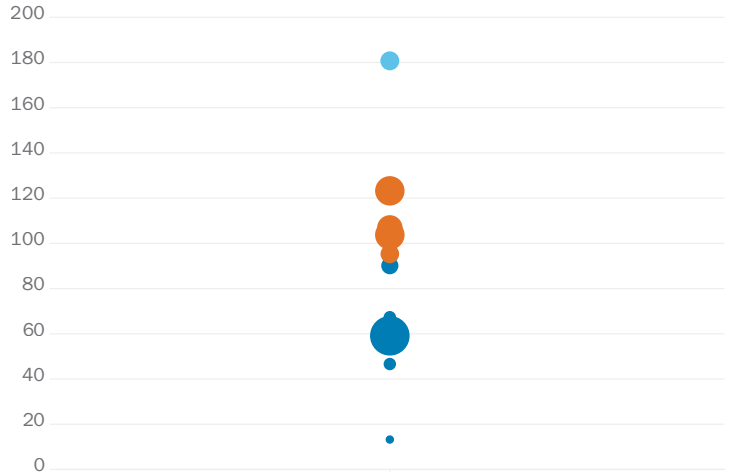
Likewise, the death rate due to fentanyl and/or heroin overdoses is noticeably higher in the region than in other parts of the Commonwealth. There

26 *Virginia Department of Health, "The Opioid Addiction Crisis is a Public Health Emergency in Virginia," November 2016*

were 11.8 deaths due to fentanyl and/or heroin in the median county, a rate that is 1.6 times the Commonwealth median. More than three-quarters of the region's population lives in a county where the death rate due to fentanyl/heroin overdose is higher than the Virginia county median.

Emergency visits for opioids were less prevalent in the region when compared to other Virginia counties, while death rates due to prescription opioid overdoses were more common. There were 6.5 deaths in the median Hampton Roads county, more than the 7.4 deaths in the median Virginia county. Portsmouth stands out for high levels of opioid overdose death rates. More than three-quarters of Hampton Roads residents live in a city where the overdose death rate is in the bottom half of Virginia counties.

Figure B-37. Emergency Department Admission Rate due to Opioids by Hampton Roads Area (2017)
Opioid-related outpatient emergency department visit rate per 100,000 population.

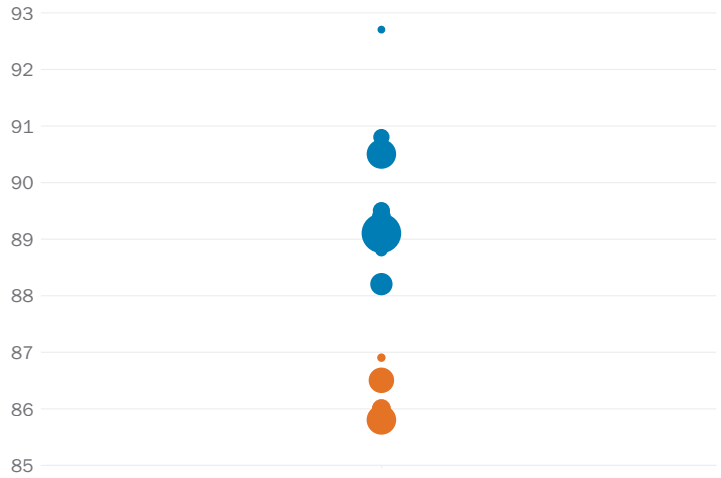


Source: Virginia Department of Health data from GHRConnects database, analysis by TEConomy

Access to Healthcare

Health insurance coverage rates for the region's population ages 18 to 64 are higher in the median Hampton Roads county than in the median U.S. county. However, more than two-thirds of the region's population (68.3 percent) lives in an area where coverage rates are below the U.S. median, which suggests that rates are lower in the region's largest cities. Although the share of adults reporting that they have visited a doctor for a routine checkup in the past year is generally higher in Hampton Roads' largest cities than in similar sized cities throughout the country, this rate is decreasing in three of the region's seven large cities.

Figure B-38. Adults with Health Insurance: 18-64 by Hampton Roads Area (2017)



Source: Small Area Health Insurance Estimates data from GHRConnects database, analysis by TEConomy

According to an interview with one expert on public health in the region, many "health disparities are driven by things that disrupt access to care or interfere with the ability of an individual to adhere to treatment plans "The region does a relatively good job of managing most chronic disease when patients can regularly access care and are compliant with treatment—the problem is figuring out and addressing why that often doesn't happen. In this way, many strategies to reduce disparities in chronic disease outcomes could be agnostic to the specific disease itself and instead focus more on mitigating the impact of other factors like those I mentioned."

Specifically, barriers to accessing care could include criminal justice system involvement, neglecting one's own health while caring for a family member, losing access to health insurance, evictions or loss of housing, experiencing a mental health crisis, lack of transportation, and others.

The most common health problems identified by Virginia Beach's community outreach finds mental health and substance abuse, access to care, and cost of care (including those who are underinsured and uninsured). Healthy literacy and education were also identified as health related problems common in Virginia Beach.

A LOOK AT HEALTH DISPARITIES IN HAMPTON ROADS ACROSS DISEASE AREAS

According to the Kaiser Family Foundation, "disparities in health and health care not only affect the groups facing disparities, but also limit overall gains in quality of care and health for the broader population and result in unnecessary costs."[27] For regions like Hampton Roads, where health needs are elevated across many disease areas, disparities are stark. This analysis looks at disparities in health areas across the Hampton Roads region, with a particular emphasis on age, race/ethnicity, and socioeconomic status.

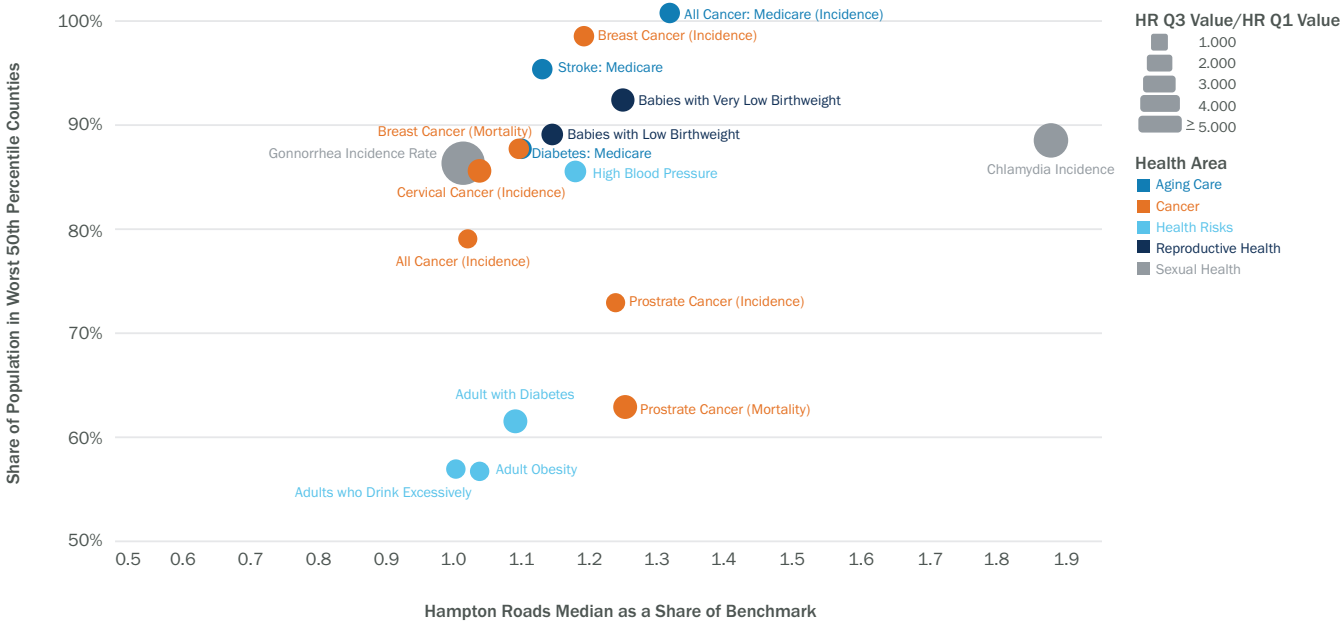
In Hampton Roads and across the nation, there is a significant economic cost because of health disparities. A recent study by the W.K. Kellogg Foundation estimates that each year approximately $93 billion in excess medical care costs and $42 billion in productivity is lost due to health disparities.[28] Furthermore, nine million potential jobs could be created nationwide if people of color owned businesses at rates comparable to whites, according to the study.

To develop a deeper understanding of health disparities in Hampton Roads, TEConomy used GHRConnects data to identify instances where the regional median was greater than the median U.S. county, and where more than one-half of the region's population lived in a county ranked below the U.S. median. This analysis identified broad areas such as cancer, sexual and reproductive health, and a category that encompasses risky health behavior. Instances where the data only looks at the Medicare population were also grouped together. Other previously discussed measures, such as substance abuse and pediatric health, were not considered due to a lack of congruent U.S. data from GHRConnects.

Figure B-39 shows the extent that the median Hampton Roads area's value is greater than the median U.S. county on the x-axis, and the share of the population in the worst 50th percentile of counties on the y-axis. The size of each bubble represents the range of values across Hampton Roads, as measured by the region's first-quartile value as a share of its third-quartile value. This figure shows only those health need areas where the Hampton Roads median is in the bottom 50th percentile of U.S. counties, and where more than half of the region's population lives in an area where the median county is in the bottom 50th percentile of U.S. counties.

27 *Kaiser Family Foundation, "Disparities in Health and Health Care: Five Key Questions and Answers," August 2018*
28 *W.K. Kellogg Foundation, "The Business Case for Racial Equity: A Strategy for Growth," April 2018*

Figure B-39. Select Hampton Roads Health Needs Compared to National Rates



Source: TEConomy analysis of indicators in the GHRConnects Database

As can be seen in Figure B-39 several disease areas stand out for their high incidence rates throughout Hampton Roads. A very high share of the region's Medicare population lives in a county in the bottom 50th percentile in the incidence of cancer, stroke, and diabetes. ___. The median chlamydia rate in Hampton Roads is nearly twice that of the U.S. county median, and nearly 90 percent of the population lives in a county where chlamydia incidence is in the bottom 50th percentile.

There are 17 measures examined across the five broad disease areas in Figure B-39. Based on these measures, TEConomy developed an overall score for each Hampton Roads geographic subunit, defined as an average of the ratio between each city's values and the benchmark median for each of the health indicators studied. Table B-8 shows the composite score for each of the five health indicators, as well as a total composite score, which is an average of the five other scores.

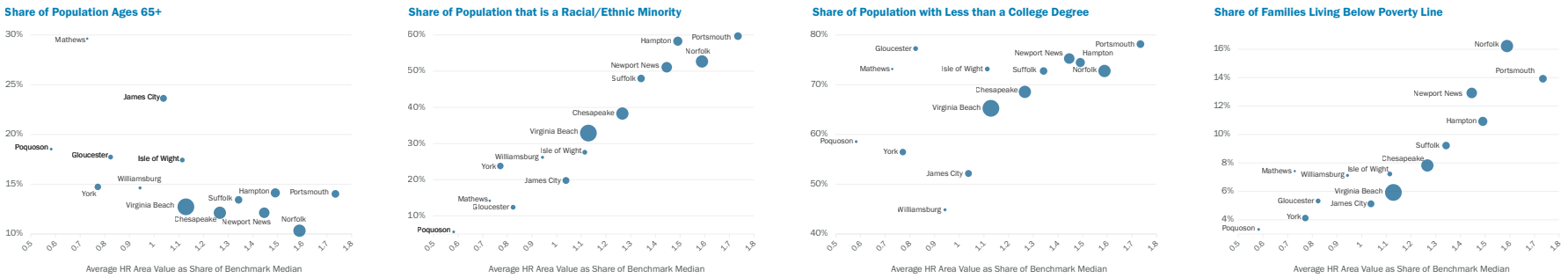
Table B-8. Average Hampton Roads Area Value as a Share of Benchmark Median, by Selected Health Need Area

Area	Average, Reproductive Health	Average, Cancer	Average, Health Risks	Average, Aging	Sexual Health	Average, All Scores
Portsmouth	1.6	1.3	2.0	2.0	1.7	1.7
Norfolk	1.3	1.2	1.7	2.3	1.5	1.6
Hampton	1.4	1.2	1.7	1.8	1.4	1.5
Newport News	1.3	1.2	1.6	1.8	1.4	1.4
Suffolk	1.3	1.3	1.4	1.5	1.3	1.3
Chesapeake	1.4	1.0	1.3	1.3	1.2	1.3
Virginia Beach	1.0	1.0	1.1	1.4	1.1	1.1
Isle of Wight	1.3	1.0	1.1	1.1	1.2	1.1
James City	1.4	0.9	1.0	0.9	1.0	1.0
Williamsburg	1.1	0.6	0.9	1.0	1.1	0.9
Gloucester	0.6	1.0	0.7	0.9	0.9	0.8
York	0.7	0.8	0.7	1.0	0.7	0.8
Mathews	1.0	0.6	0.6	0.4	1.0	0.7
Poquoson	0.6	0.5	0.6	0.5	0.7	0.6

Source: TEConomy analysis of indicators in the GHRConnects Database

Some areas in Hampton Roads are consistently doing better than benchmark value, regardless of health indicator. This is especially true for smaller and wealthier outlying counties in the region. On the other hand, cities like Portsmouth and Norfolk, and to a lesser extent Newport News, Chesapeake, and Suffolk, consistently have values that are worse than the comparison benchmark. While outliers in sexual health or substance abuse influence overall averages slightly, these cities are home to some of the region's most pronounced health needs.

Figure B-40. Average Hampton Roads Area Value as a Share of Benchmark Median, by Selected Socioeconomic Indicators

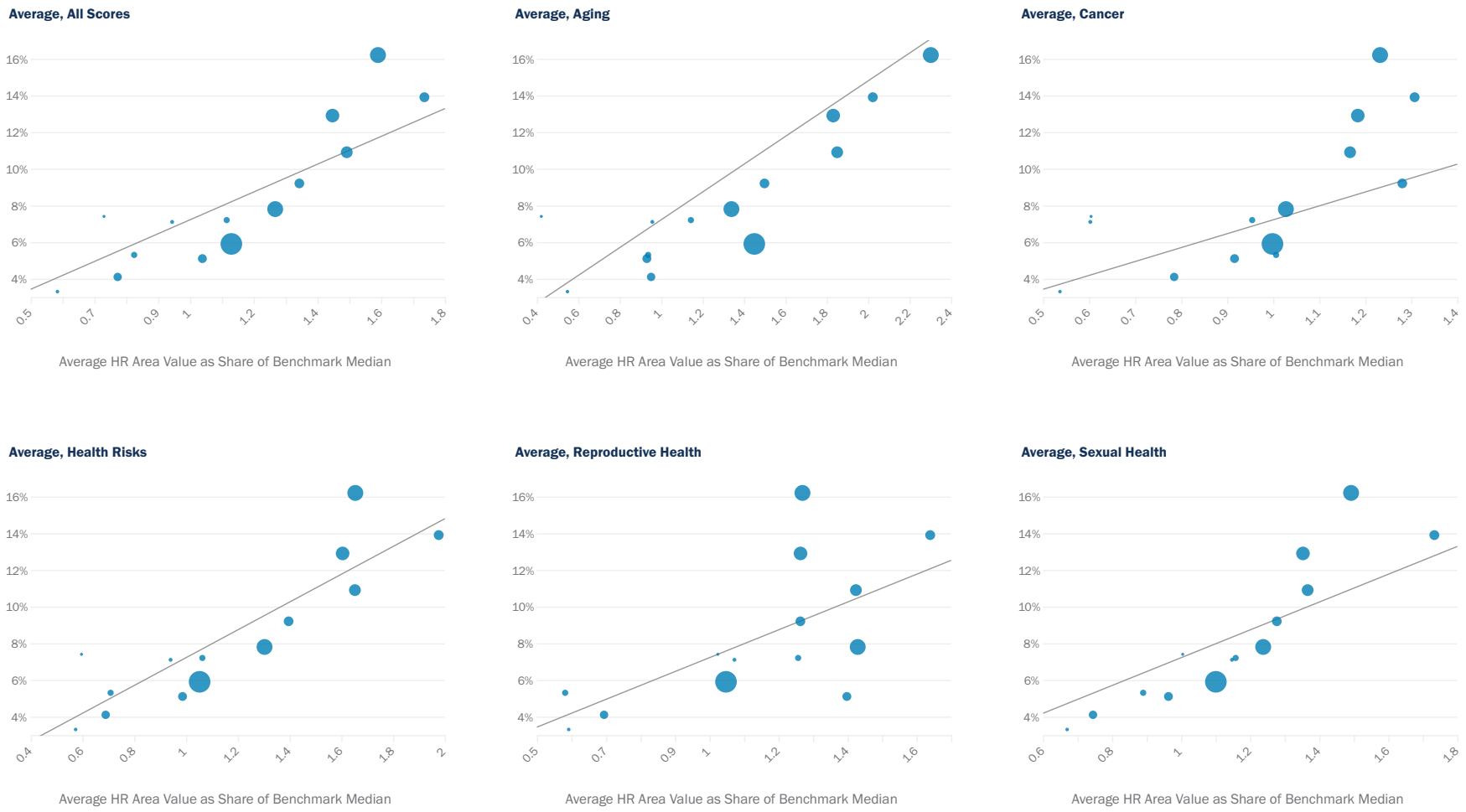


Source: TEConomy analysis of 2013-2017 ACS 5-Year Data and indicators in the GHRConnects Database

Figure B-40 shows the relationship between overall population health needs (x-axis) and four economic and demographic indicators (y-axis): the share of population ages 65 and older, that is non-white, and that is living in poverty, and that has less than bachelor's degree. Cities where health indicators were consistently worse than the benchmark appear to have higher shares of their population that are non-white, impoverished, or less formally educated, but a smaller share of population ages 65+ than healthier cities in the region.

For the selected disease areas identified above, Figures B-40 through B-43 show the relationship between average composite scores and poverty, minority population share, and educational attainment.

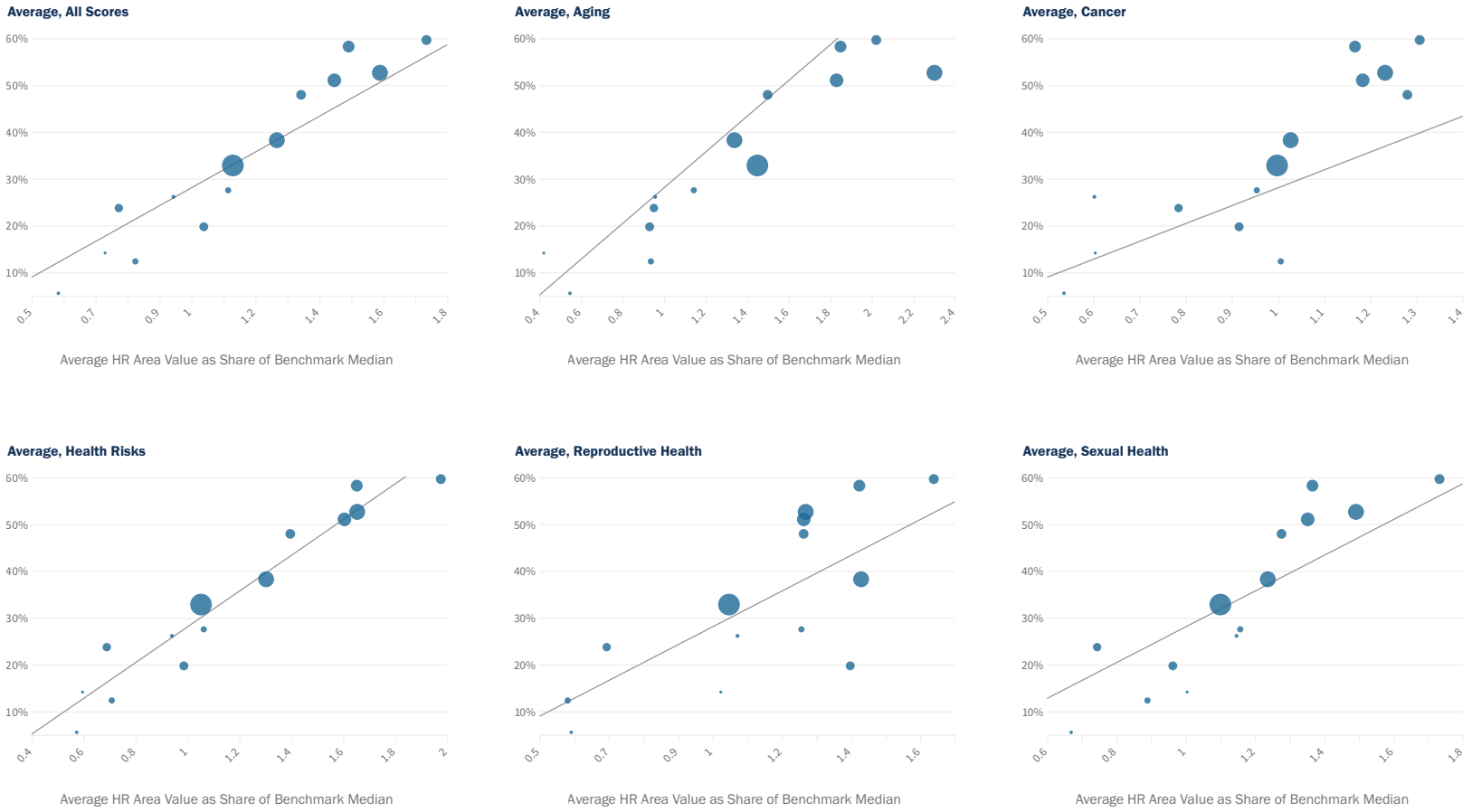
Figure B-41. Average Hampton Roads Area Value as a Share of Benchmark Median for Selected Health Need Areas, by Poverty Rate



Source: TEConomy analysis of 2013-2017 ACS 5-Year Data and indicators in the GHRConnects Database

Figure B-41 above shows the link between the share of families living below the poverty line in an area and that area's value as a share of benchmark for selected health need categories (Figure B-41). The relationship between poverty and health appears across health need areas but is especially pronounced in diseases affecting the Medicare population, indicators associated with elevated health risks, and sexual health indicators.

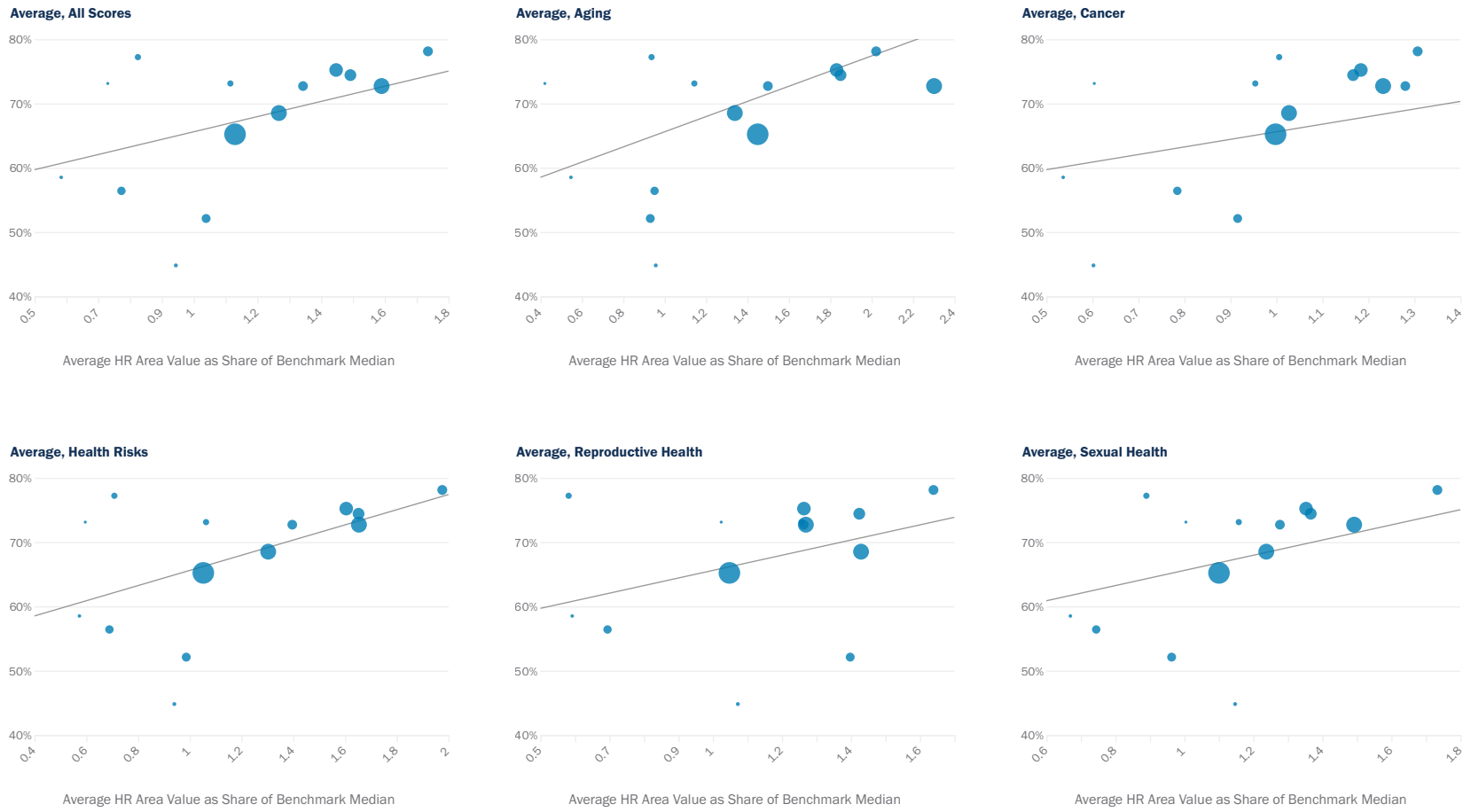
Figure B-42. Average Hampton Roads Area Value as a Share of Benchmark Median for Selected Health Need Areas, by Share of Population that is a Racial or Ethnic Minority



Source: TEConomy analysis of 2013-2017 ACS 5-Year Data and indicators in the GHRConnects Database

There also appears to be a link between the diversity of an area's population and its health needs. Hampton Roads areas with a higher share of population that is a racial or ethnic minority are especially likely to have higher rates of indicators associated with elevated health risks.

Figure B-43. Average Hampton Roads Area Value as a Share of Benchmark Median for Selected Health Need Areas, by Share of Population without a bachelor's degree



Source: TEConomy analysis of 2013-2017 ACS 5-Year Data and indicators in the GHRConnects Database

Finally, the relationship between educational attainment and population health also appears to be positive (Figure B-43) but perhaps weaker than the relationship with race/ethnicity and poverty. The health areas where the relationship with educational attainment appears to be strongest are around indicators that lead to health risks and those affecting the Medicare population.

Taken together, the Hampton Roads region is afflicted by stark disparities in population health at the city level. Many of those cities where health indicators were consistently worse than the benchmark average were also those where poverty rates were high, educational attainment rates were relatively low, and where the population was less likely to be white. Although this analysis looked at 14 geographic areas in the region, it is likely that a deeper analysis at the neighborhood or census-block level would identify further disparities across social and economic lines.

Conclusion

This appendix explores the primary health risks facing Hampton Roads' population by analyzing the overall health conditions, needs, and disparities present in the region. Publicly available community health needs assessments and improvement plans were leveraged to identify broad areas of health need. Information from these plans is supplemented by an analysis of public health data. By focusing on areas where the median Hampton Roads area fared worse than the national or Virginia medians, and by emphasizing those where a significant proportion of the region's population lives in a high-need area, a deeper understanding of population health needs is developed.

Population health needs are apparent throughout Hampton Roads, and in many instances align with the research strengths of the region's biomedical assets. In areas such as cancer, cardiovascular health, neurology and mental health, fetal and maternal health, behavioral health, and substance abuse, there are instances where the region fares poorly compared to Virginia and/or the United States.

There are considerable disparities in population health throughout Hampton Roads. The cities where population health needs are starker tend to have a higher share of their population that is a minority and that is living below the poverty line. These intraregional health disparities appear across the identified disease areas.


TECONOMY
PARTNERS LLC